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TRANSACTIONS

OF THE

IXth INTERNATIONAL CONGRESS OF ENTOMOLOGY

AMSTERDAM, AUGUST 17—24, 1951

VOLUME I

THE CONGRESS

PLENARY SESSIONS

COMMUNICATIONS AT THE SECTIONAL MEETINGS

AMSTERDAM, DECEMBER 1952

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PREFACE

Closing these Transactions, we may state with satisfaction that the Congress has shown a considerable scientific activity.

It has given some trouble to the Committee to have this book issued. The costs of printing render it more and more difficult to publish complete Proceedings of large Congresses like this. We have, therefore, thought it useful to have the General Report with the lectures given at plenary sessions and common sectional meetings printed by an inexpensive procedure. This part of the Transactions is now before you. The text of the twelve Symposia will be published in a separate volume and is issued at the same time.

Many of the members will have looked forward with impatience to the appearance of these Transactions. It will hardly be of interest to dwell on the many factors which tend to delay the birthdate of extensive, incidental publications like this. The editors have done their utmost to have the work finished in the shortest possible time.

My great thanks are due to my co-editors Dr A. Diakonoff, G.L. van Eyndhoven, L.G.E. Kalshoven, E.C.H. Kolvoort, H. Landsman and D.A. Vleugel. Several of them have spent nearly all their spare time at their editorial task. May the result give them satisfaction!

The Editorial Committee mourns the loss of its senior member J.B. Corporaal, who so ably took part in the preparations for this volume. His accuracy has been our steady example.

Finishing this Report I express the hope that this book may serve its purpose: to give a true picture of the activities of the IXth International Congress of Entomology.

J. de Wilde
Hon.Gen.Secretary

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Board of the Carnegie Museum, Pittsburgh Pa., USA.
Burr, Malcolm, c/o British Embassy Istambul, Turkey.
Colonial Office, Downing Street, London S.W. 1, Great Britain.
Department of Agriculture, Pietermaritzburg, Natal, Union of South Africa.
Department of Agriculture, Division of Entomology, P.O.Box 513, Pretoria, Union of South Africa.
Deutsches Entomologisches Institut, Waldowstr. 1, Berlin-Friedrichshagen, Germany.
Forest Entomologist, Forest Research Institute, Dehra DUN, India.
Government of Natal, Durban, Union of South Africa.
Indian Museum, Calcutta, India.
Commonwealth Institute of Entomology, British Museum (Nat. History, Crom-Road, London S.W.7.

Institut Agronomique de Gembloux, Gembloux, Belgium.

Institute de Médecine tropicale, „Prince Leopold", 155 Rue Nationale, Anvers, Belgium.

Jordan, Dr H.E.K., The Zoological Museum, Tring, Herts., Great Britain.

Literary and Philosophical Society, Newcastle-upon-Tyne, Great Britain.

Musée du Congo belge, Tervueren, Belgium.

Musée Forestier, Jardin botanique, Bruxelles, Belgium.

Musée Royal d'Histoirde naturelle, 31 rue Vautier, Bruxelles, Belgium.

Museum of comparative Zoology, Harvard College, Cambridge Mass., U.S.A.

Northamptonshire Natural History Society and Field Club, Northamtpon, Great Britain.

Royal entomological Society of London, 41 Queen's Gate, London S.W.7 Great Britain.

Société entomologique de Belgique, Musée Royal d'Histoire naturelle, 21 Rue Vautier, Bruxelles, Belgium.

Stadt-Bibliothek, Hamburg, Germany.

Transvaal Museum, Pretoria, Transvaal, Union of South Africa.

The Zoological Museum, Tring, Herts, Great Britain.

MEMBERS

Abel, Arthur, L., Pest Control Ltd., Bourn, Cambridge England.

Acatay, Gafur, Orman Fakultesi, Buyukdere-Istanbul, Turkey.

Adriani, M.J., van Maanenstraat 11 A, Rotterdam-C2, The Netherlands.

Agenjo, D.R., Concejo Superior de Investigaciones, Marqués de Urguÿo 17, 2° izgda, Madrid, Spain.

Agenjo, Mrs. M., Madrid, Spain.

Agrell, Ivar, Zoophysiological Institute, Lund, Sweden.

d'Aguilar, Jacques, Station de Zoologie Agricole, Route de St.Cyr. Versailles, (S. et O), France.

Alfieri, Anastase, Boîte Postale No. 430, Le Caire, Egypt.

Alkan, Bekir, Ankara Universitesi, Ziraat Fakültesi, Bitki Hastaliklari Estitüssü Müdürü, Ankara, Turkey.

Allan, Paul, 42 Godfrey Street, Chelsea, S.W.3, England.

American museum of natural history, Central Park West, New York, 24, N.Y. U.S.A.

Ander, Kjell, Zoological Institute, The University, Lund, Sweden.

André, Marc. 61 rue de Buffon, Paris Ve, France.

Androuin, Pierre, Shell Chimic, 45 rue d'Artois, Paris VIII^e, France.

Anquetil, Mrs., Paris, France.

Ansari, A.Rahman, Institute of Hygiene and Tropical medicine, Lahore, Pakistan.

Ardö, Paul, Zoological Institute, The University, Lund, Sweden.

Ardö, Mrs. Ann-Mari, Lund, Sweden.

Arnoux, Jacques, 19 rue Brey, Paris XVII^{e}, France.
Arora, G.L., Zoology Dept., Punjab University, Punjab, India.
Avidov, Z., Agricultural Research Station, Rehovot, Israel.
Babiy, Paul Peter, Huemerstrasse 14, Salzburg-Maxglan, Austria.
Baerends, G.P., Zoological Laboratory, Reitemakersrijge 14, Groningen, The Netherlands.
Baerends, Mrs. J., Groningen, The Netherlands.
Baeta Neves, C.M., Tapada da Ajvda, Instituto Supérior de Agronomia, Lisboa, Portugal.
Bakkendorf, Osvald, Adelgade 96–4, Copenhagen K, Denmark.
Bakker, Miss M., Tuinwijklaan 37, Haarlem, The Netherlands.
Bap Reddy, D., c/o Mr. Pratap Reddy, Police Inspector, Sultan Bazar, Hyderabad State, India.
Barendrecht, G., Chrysanthemumlaan 27, Heemstede, The Netherlands.
Barlet, Jules, Avenue de l'Observatoire 19, Liège, Belgium.
Barnes, H.F., Rothamsted Experimental Station, Harpenden, Herts., England.
Barratt, Peter R., 2 Clifton Close, Glodwick, Oldham, Lancashire, England.
Barratt, Mrs., Oldham, Lancs., England.
Barros Machado, A. de, Institut de Zoologie, Faculté des Sciences, Pôrto, Portugal.
Basu Chaudhuri, J.C., Dept. of Applied Entomology, Imperial College Field Station, Silwood Park, Sunninghill, Berks., England.
Beaufort, L.F. de, de Hooge Kley, Amersfoort, The Netherlands.
Beaufort, Mrs. J. de, de Hooge Kley, Amersfoort, The Netherlands.
Becht, G., Middenweg 308 hs, Amsterdam–E., The Netherlands.
Bechyně, Jan, Osterwaldstr. 60a, Munich, 23, Germany.
Becker, Günther, Jägerstr. 18 B, Berlin–Lichterfelde–Ost, U.S.Sector, Germany.
Becker, Mrs. Elise, Berlin, Germany.
Becking, J.H. Lawickse Allee 39a, Wageningen, The Netherlands.
Behura, B.K., Dept. of Zoology, Ravenshaw College, Cuttack 3, Orissa, India.
Beier, Max, Naturhistor. Museum, Burgring 7, Wien I, Austria.
Beier Petersen, B., Zoologisk Laboratorium, Bülowsvej 13, Copenhagen – V., Denmark.
Belderok, B., Linnaeusparkweg 18, Amsterdam–E., The Netherlands.
Belterman, Th., Jordensstraat 25, Haarlem, The Netherlands.
Bennett, Stanley H., University of Bristol, Dept. of Agriculture and Horticulture, Research Station, Long Ashton, Bristol, England.
Benning, Friedr. J., Schwindgasse 16/8, Vienna, Austria.
Benson, Robert B., British Museum (Nat.Hist.), London S.W.7, England.
Benson, Mrs. J.E., London, England.
Bentinck, G.A. Graaf, Kasteel B.14, Amerongen, The Netherlands.
Bequaert, Joseph C., Museum of Comparative Zoology, Cambridge, 38, Mass., U.S.A.
Bergerard, Joseph, Faculté des Sciences, Laboratoire de Zoologie, 1 Rue Victor Cousin, Paris, V^{e}., France.

Bergman, George, J., 448th Preventive Medicine Survey Detachment, APO 757, U.S. Army, Frankfurt/Hoechst, Germany.
Berland, Lucien, 45 bis rue de Buffon, Paris V^{e}, France.
Bonnard, J.L., Avenue E. van Becelaere 156, Bruxelles, Belgium.
Bertram, D.S., Dept. of Entom., London School of Hygiene & Tropical Medicine, Gower Street, London W.C.1., England.
Bertram, Mrs. D.S., London, England.
Besemer, A.F.H., Hartenseweg 12, Bennekom, The Netherlands.
Besemer, Mrs. W.N., Bennekom, The Netherlands.
Betrem, J.G., Duymaer van Twiststraat 51, Deventer, The Netherlands.
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Beijerinck, W., Biologisch Station, Wijster (Dr), The Netherlands.
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Blote, H.C., Wilgenlaan 14, Voorschoten, The Netherlands.
Blunck, H., Wendelstadtallee 4, Bad Godesberg, Germany.
Boardman, Mrs. Muriel, 12, Catharine Place, Bath, Somerset, England.
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Bombosch, Mrs. Ehrentraud, Frankfurt a/M, Germany.
Bonne-Wepster, Mrs. J., R.Vinkeleskade 81, Amsterdam, The Netherlands.
Bonnemaison, Lucien, Station Centrale de Zoologie Agricole, Route de St. Cyr., Versailles, France.
Bonnet, Pierre, Laboratoire de Zool. Faculté des Sciences, Toulouse, France.
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Boon, W.R., Murphy Chemical Company, Bracknell, England.
Booij, Hzn, H.L., Maastrichtsestraat 10, Scheveningen, The Netherlands.
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Borgmeier, Thomas, O.F.M., (Convento S.Antonio), Rio de Janeiro, Caixa postal 23, Petropolis, Brasil.
Boschma, H., Rijks Museum van Natuurlijke Historie, Raamsteeg, Leiden, The Netherlands.

Boström, Karl Henrik, Köpmansgatan 12, A4, Helsingfors, Finland.
Bounhiol, Jean-Jacques, 10 Avenue Jeanne d'Arc, Bordeaux, France.
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Boven, J.K.A. van, St.Christoffelstraat 2, Roermond (L), The Netherlands.
Bovenkerk, J., Oostzaanstraat 21 II, Amsterdam, The Netherlands.
Bovey, Paul, Institut d'entomologie de l'Ecole polytechnique fédérale, Universitätsstr. 2, Zürich, Switzerland.
Bovien, Prosper, Statens Plantepatologiske Forsög, Lyngby, Denmark.
Box, Harold Edmund, c/o Barclays Bank, Marine Square, Port of Spain, Trinidad, B.W.I.
Bradford, Miss B., Hawthorndale Laboratories I.C.I. Ltd, Jealott's Hill. Research Station, Bracknell, Berks., England.
Bradley, J. Chester, Dept. Entomology, Cornell Univ. Ithaca, N.Y., U.S.A.
Bradley, Mrs. J. Chester, Ithaca, N.Y., U.S.A.
Brande, Josef van den, Institut agronomique de l'état Coupure gauche 233, Gand, Belgium.
Brande, Mrs. van den, Gand, Belgium.
Bree, P. van, Plantagehuis, Vreeland, The Netherlands.
Breny, R., Chaire de Zoologie, Institut agronomique de l'Etat, Gembloux, Belgium.
Bretzler, Emma, Paedagogisches Institut, Frankfurterstrasse 40, (16) Weilburg /Lahn, Germany.
Breuning, Stephan, 45 bis, Rue de Buffon, Paris 5e, France.
Brickx, Shell belge, 21 rue de Trone, Brussels, Belgium.
Briejer, C.J., Plantenziektenkundige Dienst, Wageningen, The Netherlands.
Britton, E.B., Dept. of Entomology, Brit. Museum (Nat. Hist.), London S.W. 7., England.
Bro Larsen, Ellinor, Østervold 7, Copenhagen, Denmark.
Broadbent, Leonard, Rothamsted Experimental Station, Harpenden, Herts, England.
Broadhead, Edward, Zoology Dept. University, Leeds 2, England.
Bronzoni, U. „Sipcam", Via Dante 7, Milano, Italia.
Brouerius van Nidek, C.M.C., Vogelkersstraat 28, Bussum, The Netherlands.
Brown, A.W.A.,Dept.of Zoology, University of Western Ontario, London, Canada.
Bruel, W.E. van der, 47 avenue Seghers, Bruxelles, Belgium.
Bruggen, A.C.van, Hugo de Grootstraat 3, Leiden, The Netherlands.
Bruin, J. de, Valeriusstraat 214 hs, Amsterdam–S., The Netherlands.
Brundin, Lars, Mantinvägen 50, Bromma, Sweden.
Brundin, Mrs. Dagny, Bromma, Sweden.
Bruyn Ouboter, Miss M.P.de, Lab. voor Bloembollenonderzoek, Heereweg 347, Lisse, The Netherlands.
Buchli, Harro H.R., Laboratoire d'Evolution des Etres organisés, 105 Bd. Raspail, Paris, VIe, France.
Buchmann, W., Bodenweierstrasse 5, Bremen, Germany.
Buchner, P., c/o Museo dell'Isola d'Ischia, Via S.Alessandro, Porto d'Ischia (Napoli), Italia.

icherl, Wolfgang, Instituto Butantan, C.p.65, São Paulo, Brasil.
unn, Ralph W., 4th Medical Field Laboratory, APO 403, U.S. Army, Heidel-berg, Germany.
unt, C.F.van der, Plantenziektenkundige Dienst, Wageningen, The Netherlands.
urgerjon, A., Karl Marxstraat 43, Zaandam, The Netherlands.
urt, P.E., Dept. of Insecticides & Fungicides, Rothamsted Experimental station, Harpenden, Herts., England.
urtt, E.T., King's College, Newcastle-on-Tyne, England.
usvine, J.R., London School of Hygiene & Tropical Medicine, Keppel Street, London, W.C. 1., England.
utovitsch, Viktor, Forstl.Versuchsanhalt, Experimentalfältet, Sweden.
utt, F.H., Dept. of Entomology, Cornell University, Ithaca, N.Y., USA.
utt, Mrs. F.H., Ithaca, N.Y., USA.
utt, Mrs. A.M., Ithaca, N.Y., USA.
uxton, P.A., London School of Hygiene and Tropical Medicine, Keppel Str., London, W.C.I., England.
uxton, Miss, Grit Howe, Gerrards Cross, Bucks., England.
ytinski-Salz, H., Division of Plant Protection, Ministry of Agriculture, P.O. B. 393, Jaffa, Israel.
umeron, W.P.L., Dept. of Agriculture for Scotland, Section of Entomology and Helminthology, New Battle Abbey, Dalkeith, Midlothian, Scotland.
upra, Felice, Museo Civico di Storia Naturale „G.Doria", Via Brigata Liguria 9, Genova 116, Italia.
urayon, Jacques, 53 rue Geoffroy St.Hilaire, Paris V^{e}, France.
urpentier, Fritz, 47 rue Gaucet, Liège, Belgium.
urpentier-Lejeune, Mrs.Maria, Liège, Belgium.
urroll, John, Albert Agricultural College, Glasnevin, Dublin, Ireland.
urroll, Mrs.Kieran, Dublin, Ireland.
urthy, J.D., Dept. of Zoology, Queen Mary College, Mile End RD., London E.1., England.
urvalho, José C.M., Museo Nacional, Quinta Boa Vista, Rio de Janeiro, Brazil.
ate, J.ten, Merwedeplein 15, Amsterdam-S., The Netherlands.
ate-Kazeewa, Mrs. W. ten, Merwedeplein 15, Amsterdam-S., The Netherlands.
eballos, G., Instituto Espagnol de Entomologia, Palaco de Hippodromo, Madrid, Spain.
ejudo, S.A., Légation de Mexico, Van Lennepweg 47, Den Haag, The Netherlands.
ejudo, Mrs. S.A., Den Haag, The Netherlands.
hamberlain, R., Ministry of Agriculture, Elmwood Avenue, Belfast, Northern Ireland, England.
hamberlain, Mrs. Joan, Belfast, Northern Ireland, England.
hopard, L., 45 bis rue de Buffon, Paris, V^{e}, France.
hrysanthus, P., Beresteyn, Voorschoten, The Netherlands.
hy, Theresa, British Museum, Cromwell Rd., London S.W. 7, England.

Cloudsley Thompson, J.L., Dept. of Zoology, King's College, University of London, Strand, London W.C. 2, England.

Cloudsley Thompson, Mrs. J.A., London, England.

Cole, L.W.L., St.Helen's Court, Great St.Helen's, London E.C.3, England.

Colhoun, E.H., Biol. Control Invest., Science Service, Dept. of Agriculture, Belleville, Ontario, Canada.

Collart, Albert, 31 rue Vautier, Bruxelles, Belgium.

Collart-de Meyer, Mrs. H., Bruxelles, Belgium.

Comeau, Noel M., Musée de la Province de Québec, Canada, Quebec.

Consiglio, Carlo, Via Panama 68, Roma, Italy.

Cook, E.W., Cyanamid Products, Ltd., Bush House, N.W.Wing, Aldwych, London, England.

Cooreman, Jean, 296 Chaussée d'Alsemberg, Uccle-Bruxelles, Belgium.

Corbet, Philip, S., Dept. of Zoology, The University, Cambridge, England.

†*Corporaal*, J.B., Churchilllaan 232 II, Amsterdam, The Netherlands.

Corporaal-van Rienderhoff, Mrs. A., Amsterdam, The Netherlands.

Cory, Ernest N., State Horticultural Department, University of Maryland, College Park, Maryland, U.S.A.

Costa Lima, Angelo Moreira da, Escola Nacional de Agronomia, Cx.Postal 25, Dist.Fed., Rio de Janeiro, Brasil.

Costa Lima, Mrs. da., Rio de Janeiro, Brasil.

Coutin, Remi, Centre National de Recherches Agronomiques, Route de St.Cyr, Versailles (S. et O.), France.

Couturier, A., Station de Zoologie agricole, Cité administrative, Colmar, (Ht. Rhin), France.

Couturier, Miss Simone, Colmar, France.

Coux, Miss N. le

Cowley, J., Holywell House, Edington, Bridgwater, Somerset, England.

Crane, Miss Jocelyn, N.Y.Zool.Society, Zool.Park, New York,60, N.Y. U.S.A.

Cramer, Miss G.M.T., Zeilstraat 33, Amsterdam, The Netherlands.

Croin, Miss N., Laan van Meerdervoort 11, Den Haag, The Netherlands.

Croockewit, H.W.E., J.J.Viottastraat 27, Amsterdam, The Netherlands.

Dagnino, M., Légation de Venezuela, Grote Huizerbroekseweg 17, Wassenaar, The Netherlands.

Dalmeyer, W.H.M., Koninklijke Shell Laboratorium, Badhuisweg 3, Amsterdam, The Netherlands.

†*Dammerman*, K.W., Overburgkade 68, Voorburg, The Netherlands.

Das, G.M., Tocklai Experimental Station, Cinnamara P.O., Assam, India.

Davies, R.G., Zool.Dept., Imperial College, Prince Consort Rd., London SW.7., England.

Deal, John, Biological Institute, 2007 North Broad Street, Philadelphia, USA.

Deal, Mrs., Philadelphia, USA.

Deleurance, E.Ph., 100 Avenue de Saint Mande, Paris, XII^{e}, France.

Delmas, Ecole nationale d'Agriculture, Paris, France.

Dethier, Vincent G., Dept. Biol., The Johns Hopkins Univ., Baltimore 18, Maryland, USA.

Deutsches Entomologisches Institut, Waldowstrasse 1, Berlin–Friedrichshagen, Germany.

Diakonoff, Alexej, Lijsterstraat 36, Leiden, The Netherlands.

Dicker, G.H.L., East Malling Research Station, Maidstone, Kent, England.

Dierick, Miss G.F.E.M., Koninklijke Shell Laboratorium, Badhuisweg 3, Amsterdam, The Netherlands.

Dike, H., Universal Crop Protection Ltd. Laboratories, 2–4 Dalmeney Avenue, London N.7., England.

Dinther, J.B.M. van, Stationsweg 51, Ede, The Netherlands.

Doeksen, J., „Nijehorst", Maarn, The Netherlands.

Doesburg, P.H. van, Cantonlaan 1, Baarn, The Netherlands.

Dollfus, Robert Ph., Museum, 57 rue Cuvier, Paris V^e, France.

Dosse, G., Landwirtschaftliche Hochschule, Stuttgart–Hohenheim, Germany.

Dosse–Kohler, Mrs. Johanna, Stuttgart–Hohenheim, Germany.

Dost, Miss B.H., Jac. Bruggemalaan 76, Veendam, The Netherlands.

Dove, W.E.

Draafsel, Miss E., Zool.Lab., Kaiserstraat 63, Leiden, The Netherlands.

Dresden, D., Koningslaan 80, Utrecht, The Netherlands.

Drift, J. van der, Beukenlaan 31, Oosterbeek, The Netherlands.

Dubois, Kenneth P., University of Chicago, Toxicity Laboratory, Chicago 37, Ill., USA.

Dufrenoy, J., University of California, College of Pharmacy, The Medical Center, San Francisco 22, California, USA.

Dullemeijer, P., Falckstraat 2, Leiden, The Netherlands.

Dunn, J.A., School of Agriculture, Cambridge, England.

Dunn, Mrs., Cambridge, England.

Duprez, Mrs. K., AB Pharmacia, Box 89, Uppsala, Sweden.

Dupuis, Claude, Ecole des Hautes Etudes, C.N.R.S., 57 rue Cuvier, Paris V^e, France.

Dijkgraaf, S., Laboratorium voor Vergel. Physiologie, Jan v. Galenstraat 17, Utrecht, The Netherlands.

Dijkstra, Miss J., v. Saxen Weimarlaan 181, Amsterdam, The Netherlands.

Easter, Stephen S., Viale delle Terme di Caracallo, Roma, Italy.

Ede, R., Agricultural Department, British Embassy, 40 Kastelsvej, Copenhagen O, Denmark.

Edney, E.B., Zoology Dept., The University, Birmingham 15, England.

Efflatoun Bey, Hassan C., Abbassia, Cairo, Egypt.

Eichler, Wolfdietrich, Parasitologisches Institut, Mary Blankstr.4 II, Leipzig C.1., Germany.

Eilers, H., Koninklijke Shell Laboratorium, Badhuisweg 3, Amsterdam, The Netherlands.

Eisner, J.C., Violenweg 7, Den Haag, The Netherlands.

Eliston, Miss, 175 W. 92nd Street, New York, N.Y., USA.

Elmquist, Sölve F, Rälambsvägen 29, Stockholm, Sweden.

Elton, E.T.G., Graaf van Rechterenweg 11, Oosterbeek, The Netherlands.

Emden, F.I. van, Commonwealth Institute of Entomology, British Museum, (Nat.Hist.), London S.W.7., England.

Emergy, G.A., Murphy Chemical Company, Wheathampsted, Herts, England.

Engel, H., Zool. Museum, PL.Middenlaan 54, Amsterdam, The Netherlands.

Engel–Ledeboer, Mrs. M., Kamperfoelieweg 61, Amsterdam, The Netherlands.

Engel, Herbert, Schöneckstrasse 10, (17b) Freiburg i.Brsg., Germany.

Esaki, T., Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka, Japan.

Espanol. Francisco, Museo de Ciencias Naturales de Barcelona, Apartado Correos 593, Barcelona, Spain.

Evans, J.W., Infestation Control Div., Ministry of Agr. and Fisheries, Hook Rise, Tolworth (Surbiton), Surrey, England.

Evans, Mrs. J.W., Tolworth, England.

Evenhuis, H.H., Laboratorium van Zeelands Proeftuin, Wilhelminadorp, The Netherlands.

Evers, A.M.J., Durerstrasse 13, Krefeld, Germany.

Evers, Mrs. A.M.J., Krefeld, Germany.

Eversdijk, M.S., Geestbrugweg 46, Rijswijk, The Netherlands.

Eyndhoven, G.L. van, Floraplein 9, Haarlem, The Netherlands.

Farstad, Christian W., Field Crop Insect Laboratory, Box 270, Lethbridge, Alberta., Canada.

Feekes, F.H., Mollerusstraat 12, Baarn, The Netherlands.

Feitz, C.L.B.J., Singel 150 b, Amsterdam, The Netherlands.

Feldman–Muhsam, Mrs. B., Kiryat Shmuel, Jerusalem, Israel.

Fennah, R.G., Department of Agriculture, St. Clair, Port of Spain, Trinidad, B.W.I.

Fennah, Mrs. R.G., St. Clair, Port of Spain, Trinidad, B.W.I.

Ferrière, Charles, 57, Route de Florissant, Genève, Switzerland.

Ferrière, Mrs. Elisabeth, Genève, Switzerland.

Ferrière, Miss Mariella, Genève, Switzerland.

Ferrière, Mr. Louis, Genève, Switzerland.

Feytaud, Jean, Le Poujeau, Le Taillan-Medoc, (Gironde), France.

Finlayson, L.H., Zoology Dept., University, Birmingham 15, England.

Fischer, F.C.J., Lumeystraat 7 c, Rotterdam, The Netherlands.

Fischer–Blumer, Mrs. L.F.J., Rotterdam, The Netherlands.

Fjelddalen, Jac., Norwegian Plant Protection Institute, Dept. of Entomology, Zoologisk Museum, Oslo, Norway.

Fluiter, J.H. de, Prof. Ritzema Bosweg 39, Wageningen, The Netherlands.

Fluiter, Mrs. F.W.H. de, Wageningen, The Netherlands.

Forster, Walter, Menzingerstr. 67, Munchen, 13, Germany.

Fournier, l'Abbé Ovia, Université de Montreal, 2900, Boulevard de Mont-Royal, Montreal 26, Canada.

Fraenkel, G.S., Dept.of Entomology, University of Illinois, Urbana, Ill., USA.

Fraga de Azevedo, João, Instituto de Medicina Tropical, Lisboa, Portugal
Francke-Grosmann, Helene, Bundesanstalt für Forst- und Holzwirtschaft, Reinbek, Bez.Hamburg, Germany
Francquen, Pierre de, 12, rue Aux Laines, Bruxelles, Belgium
Francquen, Mrs. de, Bruxelles, Belgium
Fransen, J.J., Velperweg 55, Arnhem, The Netherlands
Franssen, C.J.H., de Waal Malefijtlaan 22, Heemstede post Aerdenhout, The Netherlands
Franz, Elli, Senckenberg Museum, Senckenberg-Anlage 25, Frankfurt a/M, Germany
Franz, Herbert, Bundesanstalt f.alp. Landwirtsch., Admont, Steiermark, Austria
Freeman, J.A., Ministry of Agriculture and Fisheries, Infestation Control Division, Hook Rise, Tolworth, Surbiton. – Surrey, England
Freeman, Miss J.V., West End House, Park Lane, Chippendale,Wilts, England
French, R.A., Rothamsted Experimental Station. Harpenden, Herts., England
French, Mrs. R.A., Harpenden, Herts., England
Frey, G., Osterwaldstr. 60a, München 23, Germany
Friese, Gerrit, 23 Feldstr., 21 Strasburg/Mecklenburg, Germany, D.D.R.
Galien, Mrs. Jerusalem, Israel.
Galliard, Henri, 15, rue de l'Ecole de Médécine, Paris VI^{e}, France
Galliard, Miss Martine, Paris, France
Gasser, Rudolf, c/o J.R.Geigy, Chem.Fabrik, Basel, Schweiz
Gasser, Mrs. Irma, Basel, Suisse.
Gauthier, Miss Fr., Paris, France
Geeroms, A., Sterrestraat 46, Aarsele, Belgium
Geier, Peter, Stations fédérales d'Essais viticoles, arboricoles et de chimie agricole, Lausanne, Suisse
Genderen, H. van, Vaartweg 85, Hilversum, The Netherlands
Genz, Wilhelm, Kreis Wesermunde, (23) Flögeln 95, Germany
Geijskes, D.C., Landbouwproefstation, P.O.B.306, Paramaribo, Suriname
Chesquiere, J., 87, Avenue du Castel, Bruxelles, Belgium
Gilbert, Owen, Department of Zoology, University College of North Wales, Bangor, Caernarvonshire, England
Gillard, André, Prof. Paul Fredericqstr. 15, Gent, Belgium
Gillard, Gent, Belgium
Glen, Robert, (Division of Entomology), Science Service Bldg., C.E.F., Ottawa, Canada
Godefroy, W.L., Laan van N.Oosteinde 434, Voorburg, The Netherlands
Gösswald, D., Inst. f. Angewandte Zoologie, Universität Würzburg, Röntgenring 10, Würzburg, Germany.
Goetghebuer, Maurice, rue neuve St. Jacques 39, Gand, Belgium
Goetghebuer-Planghon, Mrs. Marghérite, Gand, Belgium
Götz, B., Staatliches Weinbau-Institut, Stefan-Maierstr. 26, Freiburg/Breisgau, Germany
Gomperts, Miss L., Titiaanstraat 29, Amsterdam, The Netherlands

Goodwin Bailey, K.F., Cooper Technical Bureau, Berkhamsted, Herts., England
Gordon, R.M., School of Tropical Medicine, Pembroke Place, Liverpool 3, England.
Gordon, Mrs., Liverpool, England
Gouin, Francois, 29, Boulevard de la Victorie, Strasbourg, France.
Grandori, Remo, Instituto di Entomologia Agraria, Via Celoria 2, Milano, Italy
Grandori, Mrs. Luigia, Milano, Italy.
Grassé, Pierre Paul, Laboratoire d'évolution des êtres organisés. 105, Boulevard Raspail, Paris, VIe, France.
Gravestein, W.H., Rubensstraat 87, Amsterdam, The Netherlands
Gravestein, Mrs., Amsterdam, The Netherlands
Greenslade, R.M., Pest Control Ltd., Bourn, Cambridge, England
Grison, Pierre Armand, Station Centrale de Zool. Agricole, Route de St. Cyr., Versailles, France.
Grob, Hans, c/o J.R.Geigy A.G., Basel, Schweiz
Grob, Mrs. Marly, Basel, Schweiz.
Groetschel, Hans, Corneliusstr. 8, Postbox 39, Kettwig, Ruhr, Germany.
Groot Jr., C., Deurloostraat 120 III, Amsterdam, The Netherlands
Grünwaldt, R.W., Waltherstrasse 27, München.15, Germany.
Grünwaldt, Mrs. Ellinor, München, Germany.
Grijse, J.J. de, Science Service Bldg., C.E.F., Ottawa, Canada.
Günthart, Ernst, Wydackerstrasse, Dielsdorf, Zürich, Schweiz.
Günthart, Mrs. H, Dielsdorf, Zürich, Schweiz.
Haans, Frater A.C., Kloosterstraat 22, Goirle, The Netherlands
Haarløv, Niels, Dr Tvaergade 25–4, Copenhagen, K. Denmark.
Hackman, Walter, Parkgatan 5, Helsinki, Finland.
Hadorn, Charles, St. Johanns-Vorstadt 92, Basel, Switzerland.
Häfliger, Ernst, Bachmattenstr. 13, Binningen (Bld), Switzerland.
Haine, Miss E., Inst. f. Pflanzenkrankheiten der Universität, Kurfürstenstrasse 8, Bonn a. Rhein, Germany.
Hall, David, W., Zoology Dept., St. Andrews University, University College, Dundee, Scotland.
Hall, Mrs. Beatrice, Dundee, Scotland.
Hammad, S.M., Zoology Dept., The University, Bristol, England.
Hammen, L. van der, Waranda 53, Schiedam, The Netherlands.
Hammershøy, B., Cheminova A/S, Maaløv, Denmark.
Handschin, Eduard, Naturhist. Museum, Basel, Switzerland.
Handschin, Mrs. M., Basel, Switzerland.
Harpaz, I., Agricultural Research Station, Rehovoth, Israel.
Hartland-Rowe, R., 23 Marine Parade, Dawlish, Devon, England.
Hartsuijker, J.J.H., van Voorthuizenstraat 220, The Hague, The Netherlands.
Hartzell, Albert, Boyce Thompson Institute, 1086 North Broadway, Yonkers 3, New York, USA.
Hartzell, Mrs. Anna, Yonkers, New York, USA.

Hase, Albrecht, Biologische Zentralanstalt f. Land. u. Forstwirtschaft, Königin Luisestrasse 19, Berlin-Dahlem, Germany.

Hatch, F.W., Shell Chemical Corp., 50 West 50th Street, New York 20, N.Y. USA.

Hawley, Ira. M., P.O.Box, Moorestown, New Jersey, USA.

Hecht, Gerhard, Farben fabriken Bayer, Gewerbehygienishes Laboratorium, W. Elberfeld, Germany.

Heeley, William, Shell Experimental Station, Woodstock Farm, Sittingbourne, Kent, England.

Heerdt, P.F.van, Zoölogisch Laboratorium, Janskerkhof 3, Utrecht, The Netherlands.

Heerdt, Walter, c/o Fa. Hurdt-Lingler, Weissfrauenstrasse 9, Frankfurt/Main, Germany.

Heinze, Kurt, Biologische Zentralanstalt. Unter den Eichen 76, Berlin/Dahlem, Germany.

Heinze, Mrs. Magdalene, Berlin-Dahlem, Germany.

Hellen, Wolter, Museum Zoolog. Univ., Helsinki, Finland.

Hellen, Mrs. Mary, Helsinki, Finland.

Hemming, Francis, 28 Park Village East, Regents Park, London N.W.1, England.

Hemming, Mrs., London, England.

Hering, Erich Martin, Reichensteinerweg 21, Berlin-(West) Dahlem, Germany.

Heringa, J.W., Koninklijke Shell Laboratorium, Badhuisweg 3, Amsterdam, The Netherlands.

Hespeler, Otto, Wakenitzstrasse 62, Lübeck (Schleswig-Holstein), Germany.

Hesselbarth, G., Hindenburgstr. 13, Diepholz (Hannover), Germany.

Hill, A.R., Zoological Department University, Glasgow, England.

Hill, Mrs. Mary B., Glasgow, Scotland.

Hille Ris Lambers, D., Dikkenbergweg 14, Bennekom, The Netherlands

Hincks, W.D., Manchester Museum, The University, Manchester 13, England.

Hinton, H.E., Dept. of Zoology, University of Bristol, Bristol, England.

Hitchon, J.L., Fungicide and Insecticide Research Coordination Service, Cunard Building, 15 Regent Street, London, S.W.1., England

Hof, Miss T. Lohengrinstraat 18, Den Haag, The Netherlands.

Höne, H., Koblenzerstrasse 162, Museum Alexander Koenig, Bonn/Rhein, Germany.

Hogan, T.W., Dept. of Agriculture, Melbourne, Victoria, Australia.

Hollande, Lab. de Zoologie, Faculté d'Alger, Alger, Algerie.

Hollande, Mrs., Alger, Algerie.

Hollenkamp, H.Th., Prinses Mariannelaan 9, Voorburg, The Netherlands.

Holst Christensen, P., Sophies Schaundorphsvej 16, Kgs. Lyngby, Denmark.

Homann, Heinrich, Stegemühlenweg 61, Göttingen, Germany.

Hoogstraal, Harry, Dept. of Medical Zoology, U.S. Naval Medical Research Unit No. 3., American Embassy, Cairo, Egypt.

Hopf, H.S., Imperial Chemical Industry Ltd., Jealott's Hill Research Station, Bracknell, Berks., England.

Horber, Ernst, Kurvenstrasse 42, Zürich, 6, Switzerland.

Horber-Loos, Mrs. Martha, Zürich, Switzerland.

Hosni, M.M. Entomology Dept., Rothamsted Experimental Station, Harpenden, Herts., England.

Hosni, Mrs. Fatma, Harpenden, Herts., England.

Houten, J.G. ten, Englaan 6, Wageningen, The Netherlands.

Houten, Mrs. A. ten, Wageningen, The Netherlands.

Hove, Jules van, Gand, Belgium.

Hove, Lucie van, Gand, Belgium,

Houtman, G., Drieboomlaan 154, Hoorn, The Netherlands.

Hueck, H.J., Langebrug 87, Leiden, The Netherlands.

Hueck, Mrs. E.H., Langebrug 87, Leiden, The Netherlands.

Husaas, Ø., A/S Plantevern-Kjemi, Skøyen, Oslo, Norway.

Husson, R., Faculté des Sciences, Lab. de Biologie, Université de la Sarre, Sarrebrück 2 A, La Sarre.

Husson, Mrs. R., Sarrebrück 2 A, La Sarre.

Ilic, Budimir, Poljoprivredna fakultet, Zemun, Yougoslavia.

Instituto Biologico, bibliotece, Caixa Postal 7119, São Paulo, Brasil.

Instituto Oswaldo Cruz, Caixa Postal 926, Rio de Janeiro, Brasil.

Isings, J. The Netherlands.

Jäckl, Eberhard, c/o Museum für Natur-, Volker- und Landeskunde, Bahnhofsplatz, Bremen I, Germany.

Jancke, O., Landesanstalt für Wein-, Obst- und Gartenbau, Neustadt a.d.Weinstrasse, Germany.

Jancke, Mrs. Leni, Neustadt a.d. Weinstrasse, Germany.

Jancke, Gerd, Dieter, Neustadt a.d. Weinstrasse, Germany.

Janse, J.A., Loosterweg III no. 1, Hillegom, The Netherlands.

Jary, S.G., Appledore Rd., Tenterden, Kent, England.

Jary, Mrs F.M., Tenterden, Kent, England.

Jayewickreme, S.H., Medical Research Institute, Colombo 8, Ceylon.

Jayewickreme, Mrs., Colombo, Ceylon.

Jeannel, René, Museum National d'Histoire Naturelle, 57, rue Cuvier, Paris Ve, France.

Jeannel, Mrs., Paris, France.

Jensen, Knud, Husbukke Assurance Compagniet A/S, Dagmarkus, Copenhagen Denmark.

Jensen, Mrs. Helga, Copenhagen, Denmark.

Jepson, W.F. Imperial College Field Station, Silwood Park, Sunninghill, Berks. England.

Jeuniaux, Charles, Laboratoires de Biochemie, 17 Place Delcour, Liège, Belgium.

Johannsen, O.A., Comstock Hall, Cornell University, Ithaca, N.Y. USA.

Johansson, Arne Semb., Zool. Lab., Blindern, Oslo, Norway.

Johansson, Mrs. Eva D., Oslo, Norway.

Johnson, C.G., Rothamsted Exp. Station, Harpenden, Herts, England.
Johnson, Mrs C.G., Harpenden, Herts., England.
Jol, Miss C., Doornikschestraat 45, Scheveningen, The Netherlands.
Jones, J.W., 5525 Spain St., Nw.Orleans, La., USA.
Jong, B. de, „Retreat", Erosweg, Willemstad, Curaçao.
*Jong-*Snethlage, Mrs. A.C., Willemstad, Curacao.
Jong, C. de, Mil School.v.Hygiene en Preventieve Geneeskunde, Waardenburg, (Gld), The Netherlands.
Jong, D.J. de, Plataanstraat 5, Duivendrecht, The Netherlands.
Jordan, H.E. Karl, Brit. Museum (Nat.Hist), The Zool. Museum, Tring, Herts., England.
Jordan, Miss B.M. Hilda, Tring, Herts., England.
Jucci, Carlo, Inst. Zoologia „L.Spallanzani"., Università, Pavia, Italy.
Juutinen, Paavo, Köydenpunsjank 15 C 62, Helsinki, Finland.
Juutinen, Mrs. Helga, Helsinki, Finland.
Kabos, W.J., van Baerlestraat 26, Amsterdam, The Netherlands.
Kalshoven, L.G.E., Willemsparkweg 190 I, Amsterdam, The Netherlands.
Kalshoven, van der Brug , Mrs. H., Amsterdam, The Netherlands.
Kamal, Mohamed, Faculty of Science, Dept. of Entomology, Farouk 1st University, Alexandria, Egypt.
Kamal, Mrs., Alexandria, Egypt.
Kangas, Esko, Oulunkylä, Finland.
Kangas, Mrs. Hilkka, Oulunkylä, Finland.
Karabag, T.K., 35 Chepstow Place, London W.2., England.
Keiding, Johannes, Statens Skadedyrlaboratorium, Springforbi, Denmark.
Keiser, Fred. Marschalkenstrasse 78, Basel, Switzerland.
Keiser, Mrs. Lili, Basel, Switzerland.
Kemper, Heinrich, Robert Koch Institut f. Hygiene u. Infektionskrankheiten, Corrensplatz 1, Berlin-Dahlem (1), Germany.
Kennedy, J.S., Entomological Field Station, 34A Storey's Way, Cambridge, England.
Kernkamp, J.H.B., Raphaelplein 39, Amsterdam, The Netherlands.
Kerr, M.W., Rothamsted Experimental Station, Harpenden, Herts., England.
Kerrich, G.J., Commonwealth Inst. of Entomology, British Museum (Nat.History) Cromwell Road, London, S.W. 7., England.
Kerrich, Mrs. M., London, England.
Ketelaar, J.A.A., Lab.v.Algemene en Anorganische Chemie, Nwe Prinsengracht 126, Amsterdam, The Netherlands.
Kettle, D.S., Department of Health for Scotland, 163 West Princes Str., Glasgow, C.H., Scotland.
Kettle, Mrs. G.E., Glasgow, Scotland.
Kevan, D.K.Mc.E., Nottingham University, School of Agriculture, Sutton Connington near Loughborough, Leicestersh., England.
Kipp, P.J. Zoologisch Laboratorium, Janskerkhof 3, Utrecht.

Kips, René H., Waterstraat 69, St.Amandsberg, Gent, Belgium.
Kips, Mrs., Gent, Belgium.
Kiriakoff, S.G., Zoologisch Museum, Rijksuniversiteit 14, Universiteitsstraat Gent, Belgium.
Kirt, Edmund, A/S Sadolin og Holmblad, Holmbladsgade 70, Copenhagen, Denmark.
Klaauw, C.J. van der, Kernstraat 11, Leiden, The Netherlands.
Klijnstra, B.H., Bloemcamplaan 20, Wassenaar, The Netherlands.
Knight, Kenneth L, L.Cdr. U.S., Navy, Naval Medical Research Unit 3, c/o,American Embassy, Cairo, Egypt.
Koch, Anton, Luisestr. 14, (Zool. Institut), München 2, Germany, D.B.R.
Kolvoort, E.C.H., Koninklijke Shell Laboratorium, Badhuisweg 3, Amsterdam, The Netherlands.
Komarek, Julius, Vinicna 7, Prague II, C.S.R.
Kontkanen, Paavo, Lieksa, Finland.
Kontuniemi, Tahvo, Koskelanti 42 F 46, Helsinki, Finland.
Kontuniemi, Miss A., Koskelanti, Helsinki, Finland.
Kooistra, G., Koninklijke Shell Laboratorium, Badhuisweg 3, Amsterdam, The Netherlands.
Kruseman, G., Zoologisch Museum, afd. Entomologie, Zeeburgerdijk 21, Amsterdam, The Netherlands.
Kruseman, Mrs. M.C., Amsterdam, The Netherlands.
Kryger, I.P., Thoreby, Flintinge, Denmark.
Kryger, Mrs. Else, Plintinge, Denmark.
Kühnelt, Wilhelm, Universität, Zool. Institut, Universitätsplatz 2, Grasz, Austria.
Kuenen, D,J,, Cobetstraat 43, Leiden, The Netherlands.
Kuenen-Janssens, Mrs. L.J.Th., Leiden, The Netherlands
Kusnoto, Djalan Bubulak 25, Bogor, Indonesia.
Kutter, H., Apotheke, Flawil (Kl. St.Gallen), Switzerland.
Kuwayama, Satoru, Hokkaido Agricultural Experiment Station, Kotoni, Sapporo, Japan.
Kvicala, B.A., Plant pathology and protection research Institute, Zemedelska 1a, Brno, Czechoslovakia.
Laan, P.A. van der, Schelmscheweg 49, Arnhem, The Netherlands.
Labeyrie, Vincent, 12 Cours Gambetta, Bazas (Gironde), France.
Laboratorium voor Entomologie der Landbouw Hogeschool, Berg 37, Wageningen, The Netherlands.
Landsman, H., Talmastraat 73 c, Rotterdam, The Netherlands.
Latif, Abdul, Punjab Agricultural College, Lyallpur, Pakistan.
Lattin, Gustaf de, Geilweilerhof, Post Siebeldingen/Pfalz, Germany.
Laven, H., Bernhard Nocht Institut fur Schiffs- und Tropenkrankheiten, Hamburg 4, Germany.
Leatherdale, Donald, Old Woodstock, Oxfordshire, England.

Le Berre, Jean René, Station Centrale de Zoologie Agricole, Route de St.Cyr, Versailles (S. et O.), France.
Leclerq, Jean, 17, Place Delcour, Laboratoire de Biochemie, Liège, Belgium.
Leclerq, Mrs. Doreen, Liège, Belgium.
Leclerq, Marcel, 41, rue du Prof. E.Malvoz, Beyne-Heusay, (Lg), Belgium.
Lee, Miss S. van der, Ant.v. Dijckstraat 3 III, Amsterdam, The Netherlands.
Leefmans, S., Brederolaan 11, Heemstede, The Netherlands.
Lees, A.D., Zoöl. Dept., Downing Street, Cambridge, England.
Lees, Mrs. A.D., Cambridge, England.
Leeuwen, Miss H. van, Regentesselaan 187, Den Haag, The Netherlands.
Leeuwen, Th.H.van, (Br.Theowald), Stadhouderskade 60, Amsterdam, The Netherlands.
Legation of Hungary, 8 Oranjestraat, Den Haag, The Netherlands.
Legation of South Africa, 2c Alexander Gogelweg, The Hague, The Netherlands.
Lekander, Bertil, Statens Skogsforskningsinstitut, Experimentalfältet, Stockhom, Sweden.
Lempke, B.J., Oude IJselstraat 12 III, Amsterdam, The Netherlands.
Lems, K., Kon.Wilhelminalaan 38, Leidschendam, The Netherlands.
Lensink, B.M., Vreeswijkstraat 127, Den Haag, The Netherlands.
Lepesme, Pierre, 20, rue Cambon, Paris, 1e, France.
Lepesme, Mrs., Paris, France.
Leston, D., 44, Abbey Road, London N.W. 8., England.
Leston, Mrs. A., London, England.
Lewis, C.T., Imperial College Field Station, Ashurst Lodge, Sunninghill, Berks., England.
Levi Castillo, Roberto, P.O.Box, 3606, Guayaquil, Ecuador, S.A.
Lewis, Ernest, 8 Parry Road, South Norwood, London, S.E. 25, England.
Lhoste, Jean, 69 Rue de Miromesnil, Paris VIIIe, France.
Library, The American Museum of Nat.Hist., Central Park West at 79th Str., New York City, 24, N.Y. USA.
Library, University of Western Australia, Biology Department,Nedlands-Perth,, W.A., Australia.
Lie Giok Thwan, P.L.Takstraat 17 II, Amsterdam, The Netherlands.
Lieftinck, Maurits Anne, Museum Zoologicum Bogoriense, Bogor, Indonesia.
Lieftinck, Mrs. W.H.A., Bogor, Indonesia.
Lindberg, Haakon, Zool. Museum o/t University, Helsingors, Finland. Repres. Societas Entomologica Helsingforsiensis.
Linde, R.J.van der, A22, 's Heer Hendrikskinderen, post Goes (Z), The Netherlands.
Lindeijer, J.A., I.C.I.Ltd., Kali Besar Barat 15, Postbox 158, Djakarta, Indonesia.
Lindner, Erwin, Museum für Naturkunde, Archivstr. 3, Stuttgart, Germany.
Lindroth, Carl. H., Yuglingavägen 6, Djursholm, Sweden.
Lindroth, Djursholm, Sweden.
Lipes, J.E., 4th Medical Field Lab., APO 403, U.S.Army, Germany.

Lith, J.P.van, Allard Piersonstraat 28c, Rotterdam, The Netherlands.
Lloyd, A., Teston, Kent, England.
Löken, Astrid, Universitetet i Bergen, Zoologisk Museum, Bergen, Norway.
Long, D.B., 45 Manor Road, Lea Vaaley, Wheathampstead, Herts, England.
Long, Mrs. M.J., Wheathampstead, Herts, England.
Longfield, Miss Cynthia, 11 Iverna Gardens, London W.8., England.
Loof, P.A.A., Koninginneweg 173, Amsterdam, The Netherlands.
Loosjes, F.E., Hamelakkerlaan 24, Wageningen, The Netherlands.
Loriz, Jean, 4, Avenue Castellane, Nice, France.
Lorkovic, Zdravko, Biol. Institut, Salata, Zagreb, Yoegoslavia.
Lorkovic, Mrs. Zdenka, Zagreb, Croatia, Yoegoslavia.
Lounsky, J., Petit Vet, Gembloux, Belgium.
Louwerens, C.J., Bussummergrintweg 13, Hilversum, The Netherlands.
Lüscher, Martin, Zool. Anstalt, Univ. Basel, Switzerland.
Lüscher, Mrs., Basel, Switzerland.
Maan, W.J., van IJsselsteinlaan 7, Amstelveen, The Netherlands.
Maas Geesteranus, H., J.J.Viottasstraat 5, Amsterdam, The Netherlands.
Mc C.Callan, Edward, Dept. of Zoology and Entomology, Rhodes University, Grahamstown, South Africa.
Mc Cauley, William E., Julius Hyman & Company, Denver, Colorado, USA.
Maclagan, Stewart, West of Scotland Agricultural College, Blythswood Square, Glasgow, Scotland.
Madwar Bey, S., Ministère de l'Hygiène publique, Administration des Maladies endemiques, Cairo, Egypt.
Madwar, Mrs., Cairo, Egypt.
Maher Ali, A.E., University College, London, Zool. Dept., London W.C. 1, England.
Mani, M.S., School of Entomology, St.Johns College, Agra, India.
Manning, F.J., Cheshire County Training College, Alsager, Stoke-on-Trent, England.
Manning, Mrs. F.J., Stoke-on-Trent, England.
Manshur, Hussein, Lab. of Zoology, Fouad I University, Ghiza, Egypt.
Maqsud Nasir, M., Imperial College Field Station, Silwood Park, Sunninghill, Berks., England.
Markl, Walter, 26, Weiherweg, Basel, Switzerland.
Marks, Miss Elizabeth N., 101 Wickham Terrace, Brisbane, Queensland, Australia.
Marle, G.S.van, Primulastraat 69, Aalsmeer, The Netherlands.
Marshall, Sir Guy A.K., 31 Melton Court, South Kensington, London, S.W. 7., England.
Marshall, Lady, London, England.
Martin, H., Science Service Laboratory, University, Sub Post Office, London, Ontario, Canada.
Masne, Georges le, Laboratoire d'Evolution, 105 Boulevard Raspail, Paris, VIe, France.

asson, H., Belgian Shell Company, S.A., Division Produits Chimiques, 47, Cantersteen, Bruxelles, Belgium.
attingly, P.F., Dept. of Entomology, British Museum Nat. Hist., Cromwell Rd., London S.W. 7., England.
ayer, Arnold, Chem. Fabrik C.H.Boehringer Sohn, 16 Ingelheim/Rhein, Germany.
ayné, Raymond, 28 Avenue de la Tenderie, Boitsfort, Belgium.
eer, van der, Av.Louise 412, Bruxelles, Belgium.
eer Mohr, J.C. van der, c/o Senembah Mij, Tandjong Morawa, Sumatra Timur Indonesia.
eeuse, A.D.J., Vezelinstituut T.N.O., Mijnbouwstraat 16A, Delft, The Netherlands.
eltzer, J., N.V.Philips-Roxane, „Boekesteijn", 's Graveland, The Netherlands.
letcalf, Z.P., Box 5215, State College Station, Raleigh, N.C., USA.
enzel, Richard, Eidgen. Versuchsanstalt für Obst- Wein und Gartenbau, Wädenswil, (Kt. Zürich), Switzerland.
eurer, J.J., Hoofdstraat 204, Hillegom, The Netherlands.
iller, N.C.E., Commonwealth Institute for Entomology, London S.W. 7, 41., Queens Gate, England.
iller, Mrs. F.E., London, England.
inderman, G., I.T.B.O.N., Mariëndael, Oosterbeek, The Netherlands.
inisterio de Agricultura y Ganaderia, Division de Zoologia Agricola, Paseo Colon 922, 4° P., Buenos Aires, Argentinia.
egid el Mistikawy, Abd El, c/o Royal Agricultural Society, P.O.B. 63,Cairo, Egypt.
itic, Miss Nadezda, Baranjska 15, Zemun, Yougoslavia.
oenikes, Adalbert, Farbenfabriken Bayer, Leverkusen-Bayerwerk, Germany.
ol van Oud Loosdrecht, W.E. de, Galileiplantsoen 6, Amsterdam, The Netherlands.
ri, G., „Sipcam", Via Dante 7, Milano, Italy.
rzer Bruijns, M.F., Emmalaan 33, Utrecht, The Netherlands.
sley, F.O., Research Laboratory, The Nurseries, Uxbridge, Middx, England.
ihlow, John, Statens Växtskydsanstalt, Åkarp, Sweden.
ihlow, Mrs. Ellen, Åkarp, Sweden.
ir, R.C., 218 Hills Rd., Cambridge, England.
üller, Fritz P., Biologische Zentralanstalt, Weissenfelserstrasse 57a, (19a) Naumburg/Saale, Germany.
inchener Entomologische Gesellschaft e.V., Menzingerstrasse 67, München, Germany.
inzel, Peter, Aglukon Gesellschaft für chem.pharm.Präparate m.b.H., Vennhauser Allee 242, Düsseldorf-Gerresheim, Germany.
seo de Ciencias Naturales de Barcelona, Apartado Correos 593, Barcelona, Spain.
us, H., Odense, Denmark.

Nadler, Aaron N., 101 Ocean Parkway, Brooklyn 18, New York, USA.
Natvig, Leif Reinhardt, Univ. Zoologisk Museum, Oslo 45, Norway.
Natvig, Mrs. Karen Inger, Oslo, Norway.
Nesbitt, Herbert H.J., Carleton College, Ottawa, Ontario, Canada.
Nesbitt, Mrs. H.H.J., Ottawa, Ontario, Canada.
Nevzat Tüzdil, A., Veteriner Fakültesi, Ankara, Turkey.
Newman, J.F., I.C.I.Ltd., Hawthorndale Laboratories, Jealott's Hill, Bracknell, Berks., England.
Newman, Mrs. B.M., Bracknell, Berks., England.
Nieuwenhuis, E.J., Bentincklaan 37 a, Rotterdam, The Netherlands.
Nigar, Suat, Institut de Zoologie, Müftülük, Istanbul, Dinasinda, Turkey.
Nigar, Mrs., Istanbul, Turkey.
Nilsson, Hartvig, Stömme, Sweden.
Noirot, Charles, Laboratoire d'Evolution, 105 Bd.Raspail, Paris VIe, France
Nørgaard, Edwin, Vestergade 64, Aarhus, Denmark.
Nonveiller, Guido, Baranjska 15, Zemun, Jugoslavia.
Nuorteva, Pekka, Caloniuksenkatu 6C 64, Helsinki, Finland.
Nijveldt, W.C., Rooseveldtlaan 34 III, Amsterdam, The Netherlands.
Oertel, E., University Station of Bee Culture, Baton Rouge 3, La., USA.
Omer-Cooper, J., Rhodes University, Zoological and Entomological Dept., Grahamstown, South Africa.
Ommeren, C.van, Verdugt's Industrie N.V., Tiel, The Netherlands.
Ossiannilsson, Frej., Lantbrukshögskolan, Uppsala 7, Sweden.
Outin, Gaston, Neckarstr. 14, Karlsruhe, Germany.
Outin, Mrs. Hilde, Karlsruhe, Germany.
Painter, Reginald H., Dept. Entomology, Kansas State College, Manhattan, Kansas, USA.
Pal, Ragindar, Ass. Dir. Malayan Institute of India, Nw.Dehli, India.
Palmen, Ernst., Zool. Institute, Helsinki University, Helsinki, Finland.
Pantos, J., Plantations Ongoka par Lowa, Territoire Ponthierville, Congo Belge.
Pappenheimer Jr., A.M., 477 First Avenue, New York University, Coll. of Medecine, New York 16, N.Y., USA.
Pappenheimer, Mrs. Pauline F., New York, N.Y., USA.
Parkin, E.A., Pest Infestation Lab., London Rd., Slough, Bucks., England.
Passos, Cyril F.Dos, Washington Corners, Mendham, New Yersey, USA.
Pasternak, Franz., Wallstrasse 1, (20a) Alfeld-Leine, Germany.
Pavan, Mario, Ist. di Anatomia Comparata, Università di Pavia, Italy.
Peris, S.V., Estacion Experimental de Aula Dei., Apartado 202, Zaragoza, Spain
Perry, William J., U.S.Navy, 34 Grosvenor Square, London, W.C.1., England.
Petersen, Björn, Zool. inst., Uppsala, Sweden.
Peterson, Douglas G., St.Catharine's College, Cambridge, England.
Petrik, Miss Cvijcta, Zavad za poljoprivredna istrazivanja, Uwi Sad, Jugoslavi
Piet, D., Zool. Museum, Afd. Entomologie, Zeeburgerdijk 21, Amsterdam, Th Netherlands.
Directie van de Plantenziektenkundige Dienst, Wageningen, The Netherlands.

Plas, L.C.van der, Prins Hendriklaan 6, Oegstgeest, The Netherlands.
Pootjes, J.R., Prinses Marielaan 2, Bussum, The Netherlands.
Popov, Vassil Ivanov, Faculty of Agronomy, Sofia, Bulgaria.
Possompes, Bernard, Laboratoire de Zoologie de la Sorbonne, 1 Rue Victor Cousin, Paris Ve, France,
Potter, D., Dept. of Insecticides & Fungicides, Rothamsted Experimental Station, Harpenden, Herts., England.
Pringgopoetro, Soekotjo, Djalan Paberik Gas 40, Bogor, Java, Indonesia.
Querido, J., Consul Republ. Costa Rica., de Lairessestraat 79, Amsterdam, The Netherlands.
*Querido,*Ising, Mrs. Ch.S.W., de Lairessestraat 79, Amsterdam, The Netherlands.
Raaff, Mrs. A.F.E., Rubensstraat 87, Amsterdam, The Netherlands.
Raignier, Alb., Minderbroederstraat 11, Leuven, Belgium.
Rasek, Jaroslav, Zemedelska 1a, Brno, CSR.,
Rau, F., Rothamsted Experimental Station, Harpenden, Herts., England.
Reali, Glanco, Instituto di Entomologia Agraria, Via Celoria 2, Milano, Italy
Regnier, Robert, 16 rue Dufay, Rouen, France.
Regeren Altena, C.O.van, Louise de Colignylaan 4, Oegstgeest, The Netherlands.
Reichmuth, Werner, Sprengerstrasse 35, Celle/Hann., Germany.
Reid, E.T.M., Juba, Sudan.
Reid, J.A., Chenso, Kingsdown, Teignmouth, Devon, England.
Reiter, E., Waltherstrasse 27, München 15, Germany.
Reitter, Mrs. Ehrentraud, München, Germany.
Reyker, Miss Ad.de, 8 Ch.de Fantaisie, Lausanne, Switzerland.
Reyne, A., de Clerqstraat 124 II, Amsterdam, The Netherlands.
Gaston, Richard, Travaux Pratiques de Biologie Animale, P.C.B., 12 rue Cuvier, Paris Ve, France.
Richard, Mrs. Louise, Paris, France.
Richards, O.W., Imperial College, Dept. of Zoology, Prince Consort Road, London, S.W. 7., England.
Richards, Mrs., London, England.
Riehm, E., Unter den Eichen 76, Berlin-Dahlem, Germany.
Riley, N.D., British Museum (Nat.Hist), Cromwell Rd., London S.W.7., England
Riley, Mrs. E., London, England.
Ripper, Walter E., Pest Control Ltd., Cambridge, England.
Rivenhall Coffe, E., Winton Cottage, King's Somborne, Hants., England.
Rivnay, E., Plant Protection Section, Ministry of Agriculture, Tel-Aviv, Israel.
Rodrigues Pereira, A.S., Newtonstraat 35, Amsterdam, The Netherlands.
Roebuck, Arnold, The Laurels, Kegworth-Derby, England.
Roepke, W.K.J., Diedenweg 12, Wageningen, The Netherlands.
Roepke, Mrs., Wageningen, The Netherlands.
Röpcke, Miss E., Amsterdam, The Netherlands.
Roos, Miss Joh., Frans Netscherlaan 21, Santpoort, The Netherlands.

Rossem, G.van, Javastraat 12, Wageningen, The Netherlands.

Rossem, Mrs. van, Wageningen, The Netherlands.

Rota, P., Celoria 2, Milano, Italy.

Ryberg, Olof, State College of Agriculture, Dairy and Horticulture, Alnarp, Åkarp, Sweden.

Saalas, Uunio, Annankatu 29, Helsinki, Finland.

Saalas, Mrs. Anna-Liisa, Helsinki, Finland.

Saalas, Miss Laura, Helsinki, Finland.

Saalas, Antero, Helsinki, Finland.

Sabrosky, Curtis W., Bureau of Entomology and Plant Quarantine, U.S. Dept. of Agriculture, Washington 25, D.C., USA.

Sabrosky, Mrs. Curtis W., Washington, USA.

Sacantanis, Kyriacos, 18, Bd.Jourdan, Paris 14e, France.

Salas, L.A., Div. de Entomologia, Ministerio de Agricultura y Cria, Apartado 4643, Maracay, Venezuela.

Samuel, G.Graham, Agricultural Research Council, 15 Regent Str., London, S.W. 1., England.

Sanpere, J.M., Instituto de aclimatacion, Almeria, Spain.

Sant, L.E. van 't., Patroclosstraat 20 I, Amsterdam, The Netherlands.

Santaella, J.R., Legation d'Espagne, Daendelsstraat 41, Den Haag, The Netherlands.

Schaeffenberg, Bruno, Zoologisches Institut, Universitätsplatz 2, Graz, Austria.

Schatz-Kopuit, Mrs.S., Kijkduinstraat 62 II, Amsterdam, The Netherlands.

Schedl, K.E., Waldstation f. Forstschutz, Bodensdorf, Kärnthen, Austria.

Scheffer, Miss Joh., Hobbemakade 116, Amsterdam, The Netherlands.

Schierenberg, R., Brouhuissteeg, Lochem, The Netherlands.

Schippers, Miss A.C., Deurloostraat 129, Amsterdam, The Netherlands.

Schmitz, S.J., Hermann, Elisabethstraat 18, Aloisiuskolleg, 22c Bad Godesberg, Nordrhein-Westfalen, Germany.

Schneider, Fritz, Eidgen.Versuchsanstalt für Obst-, Wein- und Gartenbau, Wädenswil (Zürich), Switzerland.

Schneider, Mrs. Emma, Wädenswil (Zürich), Switzerland.

Schweiger, Harald, Franklinstr. 16, Wien 21, Austria.

Scossiroli, Renzo, Dept. of Genetics, Univ. of Pavia, Italy.

Scott, Hugh, Ancastle Cottage, Gravel Hill, Henley on Thames, England.

Sellick, G., Glasgow, Scotland.

Sellier, Chef de Travaux, Institut Nationale Agronomique, Paris, France.

Seventer, H.A.van, Nic.Maesstraat 133 I, Amsterdam, The Netherlands.

Seydel, Charles, B.P. 712, Elisabethville, Congo Belge.

Shih Chun Ma, Entomology Dept., University of Minnesota, St.Paul,Minnesota, USA.

Shoumatoff, Nicholas, Bedford, N.Y., USA.

Shulov, Aharon, The Hebrew University, Jerusalem, Israel.

Shute, P.G., Malaria Laboratory, Harton Hospital, Epso, Surrey, England.

iddorn, J.W., Imperial College Field Station, Silwood Park, Sunninghill, Berks., England.
ingh, B.P., Kaithi, Banaras, U.P., India.
mart, John, Dept. of Zool., Downing Str., Cambridge, England.
mith, L.G., Shell Chemical Corp., 50 West 50th Str., New York,20, N.Y., USA.
obels, F.H., Zool. Laboratorium, Janskerkhof 3, Utrecht, The Netherlands.
ociedade Brasileira de Entomologia, Caixa Postal 9063, Sao Paulo, Brasil.
ocietas Entomologica Fennica, Snellmanink 5, Helsinki, Finland.
ociete Fouad Ier d'Entomologie, Boite Postale No.430, Le Caire, Egypt.
oenen, Albert, 18 Av.Prince Albert, St.Trond, Belgium.
olomon, M.E., Pest Infestation Laboratory, London Rd., Slough, Bucks, England.
paan, W.P., Burg. Peecklaan. Schoorl, The Netherlands.
parck. R., Zoologisk Museum, Krystalgade 27, Copenhagen, Denmark.
pear, P.J., University of Massachusetts, Amherst, Mass., USA.
pence, L., Ministry of Agriculture and Fisheries, Veterinary Laboratory, New Haw, Webridge, Surrey, England.
peyer, Walter, Biologische Bundesanstalt für Land- u.Forstwirtschaft, Kitzeberg bei Kiel, Germany.
tammer, Hans Jürgen, Universitätsstr. 18, Erlangen, Germany.
tammeshaus, H.J.L.T., Grensstraat 15 hs., Amsterdam, The Netherlands
tapley, J.H., Plant Protection Ltd., Research Station, Fernhurst near Haslemere, Surrey, England.
tapley, Mrs., Fernhurst, near Haslemere, Surrey, England.
tassen, Miss C., Scheldestraat 169 III, Amsterdam, The Netherlands.
teen, Olaf, c/o N.V. Hercules Powder Cy., Postbus 89, Den Haag, The Netherlands.
egwee, D., Henri Polaklaan 28, Amsterdam, The Netherlands.
empffer, Henri, 4, rue St.Antoine, Paris 4e, France.
empffer, Mrs. Yvonne, Paris, France.
oker, W.J., Eykman Institut, Djakarta, Java, Indonesia.
rickland, A.H., Plant Pathology Lab., Milton Rd., Harpenden, Herts, England.
rid, Olof, Tegnergatan 45, Stockholm, Sweden.
rid, Mrs. Gulli, Stockholm, Sweden.
ride, G.O., Dept. of Zoology, The University, Bristol, England.
royan, H.L.G., Agricultural Research Council, Dept. of Zoology, Downing Str., Cambridge, England.
ubbe Teglbjaerg, K.E., Lindholmsvej 11, Copenhagen, Denmark.
ubbe Teglbjaerg, Mrs. M., Copenhagen, Denmark.
an, D.C., Waite Agric.Res.Institute, Private Mail Bag, Adelaide, Australia.
eetman, Harvey L., Univ. of Massachusetts, Amherst, Mass., USA.
eetman, Mrs. Olive H., Amherst, Mass., USA.
ellengrebel, N.H., Mauritskade 57, Amsterdam, The Netherlands.
ierstra, D., Inst. voor Veterinaire Parasitologie en Parasitaire Ziekten, Biltstraat 168, Utrecht, The Netherlands.

Sy, Max-Heinz, (20) Seelze bei Hannover, Fa Riedel-de Haën, Germany.
Szumkowski, Waelaw, Division de Entomologia, M.A.C., Apartado 4643, Mara cay, Estado Aragua, Venezuela.
Taylor, T.H.C., Commonwealth Institute of Entomology, 41, Queens Gate London S.W. 7., England.
Taylor, Mrs., London, England.
Teixeira Feijo Colaco, Amadeu, Instituto de Medicina Tropical, Lisboa, Portugal.
Terpstra, P., Brink 13, Postbus 10, Deventer, The Netherlands.
Terstege, Günsburg, Germany.
Teunissen, H.G.M., Julianastraat 13, Berghem, The Netherlands.
Thalenhorst, Walter, Forstpathologisches Institut der Niedersachsischen Forstlichen Versuchsanstalt, Sieber über Herzberg/Harz, No. 34, Germany.
Theodor, O., Department of Parasitology, Hebrew University, Jerusalem, Israe
Theodorides, Jean, Laboratoire Arago, Banyuls s/mer, (P.O.). France.
Thiel, P.H.van, Johan de Wittstraat 8, Leiden, The Netherlands.
Thomas, I., Plant Pathology Lab. 28 Milton Rd., Harpenden, Herts. England.
Thomas, Mrs. G.M., Harpenden, Herts, England.
Thonon, Miss Georgette, 32, quai de la Derivation, Liège, Belgium.
Tiensuu, L., Runeberginkatu 53 B 50, Helsinki, Finland.
Tilemans, Em.M., 43, rue Ernest Salu, Brussels, Belgium.
Tilemans, Mrs., Brussels, Belgium.
Tillyard, Mrs. R.J., Canberra, Australia.
Timmermans, A., Rooseveltlaan 87 I, Amsterdam, The Netherlands.
Tominic, Ante, Institut za jadranski kulture, Split, Jugoslavia.
Toth, Laszlo, Institute for Microbiology, Uppsala 7, Sweden.
Treherne, John E., Dept. of Zoology, The University, Bristol, England.
Trouvelot, B., Station Centrale de Zoologie Agricole, Versailles, France.
Tuxen, S.L., Zool. Museum, Copenhagen, Denmark.
Tuxen, Mrs. Jytte, Copenhagen, Denmark.
Ulman, E., Stauffen/Breisgau, Germany.
Ulmann, Mrs., Stauffen/Breisgau, Germany.
Uvarov, B.P., British Museum N.H., London S.W.7., England.
Uvarov, Mrs. A.F., London, England.
Varley, G.C., University Museum, Oxford, England.
Vayssiere, Paul, 2 rue du Val de Grâce, Paris Ve, France.
Vayssiere, Mrs., 2 rue du Val de Grâce, Paris Ve, France.
Vecht, J.van der, General Agricultural Research Station, Bogor, Indonesia.
Vecht, Mrs. E.van der, Bogor, Java, Indonesia.
Veenhof, M.J., Postbus 10, Deventer, The Netherlands.
Vellard, J., Centre Français d'Etudes Andines, San Marcelo 325, Lima, Peru.
Verbeke, J.L., Commonwealth Bureau of Biological Control, Seestrasse 139., Feldweilen (Zürich), Switzerland.
Verberne, Miss G., Dennenweg 21, Bloemendaal, The Netherlands.
Vestergaard, Miss Karen, Statens skadedyrlaboratorium, Strandvejen 740, Springforbi, Denmark.

Vietinghoff-Riesch, Frhr.von, Forstzoologisches Institut d.Univ.Göttingen, (20) Hann.Münden, Germany.
Viette, P.E.L., Laboratoire d'Entomologie, Museum, 45 bis Rue de Buffon, Paris, Ve, France.
Vinson, J.L.Jean, Mauritius Institute, Port Louis, Mauritius.
Viveen, W.J.C., Postbus 10, Deventer, The Netherlands.
Vliet, N.C.van der, K.Leidsedwarsstr. 141, Amsterdam, The Netherlands.
Vleugel, D.A., A.de Haenstraat 53, Den Haag, The Netherlands.
Vondracek, Theod.
Vos, J.H.,N.V.Philips-Roxane, „Boekesteijn", 's-Graveland, The Netherlands.
Vos tot Nederveen Cappel, J.J.de, Burggravenlaan 5, Leiden, The Netherlands.
Voss, Miss G.C., Amsteldijk 114, Amsterdam, The Netherlands.
Voute, A.D., „Mariendaal", Oosterbeek, The Netherlands.
Voute, Mrs. A.M., Oosterbeek, The Netherlands.
Vrie, M.van de, Patijnweg 4, Goes, The Netherlands.
Wagenaar Hummelinck. P., Beethovenlaan 24, Bilthoven, The Netherlands.
Wagn, Ole, Skovgardsvej 20 F, Charlottenlund, Denmark.
Wagner, Oskar, Farbwerke Hoechst, Frankfurt/Main-Höchst, Germany.
Waloff, N., Dept. of Zoology and Applied Entomology, Imperial College, Prince Consort Rd., London S.W. 7., England.
Waloff, Miss Z., Anti Locust Research Center, British Museum, Nat.Hist., Cromwell Rd., London, S.W.7., England.
Warnecke, Georg, Hohenzollernring 32, Hamburg–Altona, Germany.
Warnecke, Mrs. Margarethe, Hamburg, Germany.
Watson, Mrs. Marion A., Rothamsted Experimental Station, Harpenden, Herts., England.
Webb, J.E., Dept. of Zoology, University College, Ibadan, Nigeria.
Webb, Mrs. G.C., Ibadan, Nigeria.
Weidner, Herbert, Jungiusstr. 6, Zool. Staatsinst. u. Zool. Museum, 24a Hamburg 36, Germany.
Weis-Fogh, T., Skovkrogen 7, Charlottenlund, Denmark.
Weisbach, I., van Stolkweg 13, Den Haag, The Netherlands.
Weisbach, Walter, van Stolkweg 13, Den Haag, The Netherlands.
Weisbach-Junk, Mrs. I.M., Den Haag, The Netherlands.
Wellenstein, G., Württembergische Forstschutzstelle, Ringingen, Germany.
Wey, H.G.van der, Torenlaan 50, Blaricum, The Netherlands.
Wichmand, Hans, Statens Skadedyrlaboratorium, Strandvejen 740. Springforbi., Denmark.
Wichmand, Mrs. Grete, Springforbi, Denmark.
Wiel, P.van der, Ger.Terborgstraat 23, Amsterdam, The Netherlands.
Wiel, Mrs. van der, Amsterdam, The Netherlands.
Wiering, H., Govert Flinckstraat 16, Zaandam, The Netherlands.
Wigglesworth, V.B., Dept. of Zool., Downingstreet, Cambridge, England.
Wilcke, J., Hartenseweg 22, Bennekom, The Netherlands.
Wilde, J.de, Linnaeushof 61 hs., Amsterdam, The Netherlands.

Wilde-van Buul, Mrs. G.de, Amsterdam, The Netherlands.
Willemse, C., Eygelshoven, L., The Netherlands.
Willemse-Widdershoven, Mrs., Eygelshoven, L., The Netherlands.
Williams, C.B., Rothamsted Experimental Station, Harpenden, Herts., England
Williams, Mrs. E.M., Harpenden, Herts., England.
Williams, D.W., Dept. of Agriculture for Scotland, 69 Berkeley Square, Glasgow C.3, Scotland.
Williams, Mrs. D.W., Glasgow, Scotland.
Wilson, Hans, Jakobstog 3, Stockholm, Sweden.
Wilson, Kent H., Dept. of Biol. Sciences, Univ. of Idaho, Moscow, Idaho, USA
Wilson, S.G., Veterinary Res. Lab., Kabete, Nairobi, Kenya, Br.East, Africa.
Wiltshire, E.P., c/o T.P. Wiltshire, St.Margarets, Herringfleet nr Lowestoft, Suffolk, England.
Wiltshire, Mrs. E.P., Herringfleet, England.
Wirtz, H.A.A.M., Handelmij Interveelo, Keizersgracht 416, Amsterdam. The Netherlands.
Wohlfahrt, Th.A., Zoologisches Institut der Universität, Röntgenring 10, Würzburg, Germany.
Wohlfahrt, Miss Paula, Würzburg, Germany.
Wolcott, G.N., University of Puerto Rico, Agricultural Exp.Station, Rio Piedras Puerto Rico.
Wolfe, L.S., Dept.of Zoology, Downing Str., Cambridge, England.
Wolfinson, Jerusalem, Israel.
Wolfram, Mrs. Rosemarie, c/o Deutsche Gesellschaft für Schädlingsbekämpfung Weissfrauenstrasse 9, Frankfurt/Main, Germany.
Wolvekamp, H.O., Regentesselaan 45, Oegstgeest, The Netherlands.
Worms, Charles G.M.de, 26 Common Close, Horsell, Woking, Surrey, England.
Wragge Morley, Derek, 14 B Downshire Hill, Hamstead, London N.W.3, England.
Wragge Morley, Mrs. D., London, England.
Wright, D.W., School of Agriculture, Downingstreet, Cambridge, England.
Wright, Mrs., Cambridge, England.
Yagi, N., The Faculty of Textile and Sericulture, Shinshu Univ. Ueda City, Japan.
Yuasa, Hiroharu, National Institute of Agricultural Sciences, Nishigahara, Tokyo, Japan.
Zacher, Friedrich, Zimmermanstr. 31, Berlin-Steglitz, Germany.
Zacher, Mrs. Lina, Berlin-Steglitz, Germany.
Zadoks, J.C., Reguliersgracht 34b, Amsterdam, The Netherlands.
Zeegers, R.A., Chasséstraat 33, Amsterdam, The Netherlands.
Zeuner, F.E., Institute of Archeology, Inner Circle, Regents Park, London, N.W 1, England.
Zinkernagel, Robert, 12, Sieglinweg, Riehen/Basel, Switzerland.
Zoheiry Bey, M.S.El, Plant Protection Dept., Dokki, Egypt.
Zwijns, M.J., Croeselaan 102 bis, Utrecht, The Netherlands.

ADDITIONS

ro Larsen, Mrs. E., Østerwald 7, Copenhagen, Denmark.
ayward, K.J., Inst. de Entomologia de la Universidad, Tucumán, Argentine.
awson, J.W.H., Dept. of Zoology, The University, Glasgow, Scotland.
useum of Natural History, Dept.of Zoology, Baross Utca 13, Budapest VIII, Hungary.
agden, H.T., Dept.of Agriculture, Kuala Lumpur, Malaya.
ol, P.H.van de, Hullenberglaan 7, Bennekom, The Netherlands.
ol, Mrs. van de, Bennekom, The Netherlands.
ocietas Entomologica Fennica, Snellmaninkatu 5, Helsinki, Finland.
vierstra, J., Mathenesserlaan 322 A, Rotterdam, The Netherlands.
illink, A., Instituto de Entomologia de la Universidad, Tucumán, Argentine.
appi Recordati, A., Viale Regina Margherita 199, Roma, Italy.
agner, E., Moorreije 103, Hamburg-Lgh., Germany.
mic, C., Kosovska ul. 1, Beograd, Yugoslavia.
opov, G.B., c/o British Museum (Nat. History), Cromwell road, London S.W.7, England.
ateu, M.,. Spain.

OFFICIAL DELEGATES FROM GOVERNMENTS, UNIVERSITIES, SOCIETIES AND INSTITUTES

(For qualifications and addresses see list of members)

ARGENTINE

Ministry of Education
Dr K.J. *Hayward*, Tucuman
Dr A. *Willink*, Tucuman

AUSTRALIA

Government, and
Australian National Research Council
Mr R.W. *Kerr*, Melbourne, Victoria

BELGIUM

Inst. royal des sciences naturelles
Dr A. *Collart*, Bruxelles
Dr J. *Cooreman*, Bruxelles
Université de Liège
Prof. F. *Carpentier*, Liège

BRASIL

Universidade do Brasil
José C.M. *Carvalho*, Ph.D. Rio de Janeiro
Instituto Oswaldo Cruz, Rio de Janeiro
and
Sociedade Brasileira de Entomologia
Dr A.M. da *Costa Lima*, Sao Paulo

CANADA

Government
Dr R. *Glen*, Ottawa
Dr C.W. *Farstad*, Lethbridge, Alberta
Mr J.J. de *Gryse*, Ottawa
Dr H. *Martin*, London, Ontario
Mr G.E. *Shewell*, Ottawa

CEYLON

Government
Dr S.H. *Jayewickreme*, Colombo

CHILI

Government

Ing. Agron. G. *Olalquiaga Fauré*, Santiago

DENMARK

Government

Prof. Dr R. *Spärck*, Copenhagen

Zoological Museum of the University of Copenhagen

Dr S.L. *Tuxen*, Copenhagen

EGYPT

Government

Monsieur *Mohammed Soliman El Zoheiry*, Directeur général de l'Administration de la Protection des Plantes (Ministère de l'Agriculture)

Monsieur *Saadallah Madwar*, Directeur général de l'Administration des Maladies endémiques (Ministère de l'Hygiène publique)

Ibrahim University, Faculty of Science Giza (Orman)

Prof. M.T. *Sayed*, Giza (Orman)

Société Fouad Ier d'Entomologie

Prof. H.C. *Efflatoun Bey*, Le Caire.

Royal Agricultural Society of Egypt

Prof. A. *Megid el Mistikawi*, Cairo

EIRE

Department of Agriculture, and University College, Dublin

Dr John *Carroll*, Dublin

FINLAND

Societas Entomologica Helsingforsiensis

Dr. H. *Lindberg*, Helsinki

FRANCE

Government

Prof. R. *Jeannel*, Paris
L. *Berland*, Paris
Blanc
Dr L. *Chopard*, Paris
Prof. *Delmas*
R.Ph. *Dollfus*, Paris
Dr Fr. *Couin*, Strassbourg
Prof. Dr P.P. *Grassé*, Paris
Ed.Ph. de *Leurance*, Paris
Dr R. *Régnier*, Rouen
Sellier, Paris
P.E.L. *Viette*, Paris

Université de Bordeaux

Prof. J.J. *Bounhiol*, Bordeaux

Institut National de la Recherche Agronomique, et Société Française de Physiatrie et Phytopharmacie

Dr R. *Régnier*, Rouen

GERMANY

Biologische Zentralanstalt für Land- und Forstwirtschaft, Berlin-Dahlem

Prof. Dr Albrecht *Hase*, Berlin

Deutsches Entomologisches Institut

Prof. Dr Hans *Sachtleben*, Berlin

Münchener Entomologisches Gesellschaft

Dr Walter *Forster*, München

GREECE

Université d'Athènes

Prof. Georges *Pantazis*

Université de Thessalonique

Prof. Jean *Koroneos*

INDIA

University of Agra

Professor M.A. *Mani*, Agra

Indian Tea Association, Assam

Dr G.M. *Das*, Assam

INDONESIA

Government

Ir *Kusnoto*, Bogor

Dr M.A. *Lieftinck*, Bogor

Dr J. *van der Vecht*, Bogor

Mr *Sukotjo Pringgopoetro*, Bogor

ISRAËL

The Hebrew University

Prof. F.S. *Bodenheimer*, Jerusalem

ITALY

Government

Prof. Dr *Guido Grandi*, Bologna

Prof. *Filippo Venturi*, Pisa

Ministère de l'Agriculture

Prof. *Remo Grandori*

JAPAN

Science Council of Japan
Prof. *Teiso Esaki*, Fukuoka
Mr *Hiroharu Yuasa*, Tokyo
Prof. *Nobumasa Yagi*, Ueda
Mr *Satoru Kuwayama*, Sapporo

KENYA

Department of Veterinary Service, Kabete
Dr S.G. *Wilson*, Kabete

LAOS

Government
Prof. R. *Jeannel*, Paris

MALAYA

Federation of Malaya, Department of Agriculture
Mr H.T. *Pagden*, Kuala Lumpur

MEXICO

Government
Mr S.A. *Cejudo*, The Hague, Netherlands

NETHERLANDS

Natuurhistorisch Genootschap in Limburg
Dr H. *Schmitz*, S.J., Bad Godesberg, Germany
Kapelaan J.K.A. van *Boven*, Roermond

NEW ZEALAND

The Royal Society of New Zealand
Dr J.T. *Salmon*, Wellington

NORTHERN IRELAND

Ministry of Agriculture
Dr R. *Chamberlain*, Belfast

NORWAY

Government
Dr L.R. *Natvig*, Oslo
Norvegian Entomological Society
Prof. Dr A.S. Johannsen, Oslo
University of Bergen
Miss Astrid *Löken*, Bergen

PAKISTAN

Government

M. *Maqsud Nasir,* Sunninghill, Berks., England

PORTUGAL

Ministry of Education
and
Instituto Superior de Agronomia

Prof. C.M. *Baeta Neves,* Lisboa

SWEDEN

State College of Agriculture, Dairy and Horticulture

Dr Olof *Ryberg,* Akarp

SWITZERLAND

Le Conseil Fédéral Suisse

Prof. Dr E. *Handschin,* Bale

Eidgenossische Landwirtschaftliche Versuchsanstalt

Dr E. *Horber,* Zürich–Oerlikon

TRINIDAD

Government

Mr R.G. *Fennah,* Trinidad

TURKEY

Government

Prof. Dr *Bekir Alkan,* Ankara

UNITED KINGDOM

Royal Society

Dr B.P. *Uvarov,* London
Dr V.B. *Wigglesworth,* Cambridge

British Museum (Natural History)

Mr N.D. R*iley,* London
Mr R.B. *Benson,* London
Mr E.B. B*ritton,* London
Miss Th. *Clay,* London

Ministry of Agriculture and Fisheries

Dr J.W. *Evans,* Tolworth-Surbiton, Surrey
Dr A.J. *Freeman,* Tolworth-Surbiton, Surrey
Mr A. *Roebuck,* Kegworth, Derby
Mr T. *Spence,* Waybridge, Surrey
Mr A.H. *Strickland,* Harpenden, Herts
Dr I. *Thomas,* Harpenden, Herts

Department of Scientific and Industrial Research

Dr R.C. *Fisher,* Aylesbury, Bucks

Dr E.A. *Parkin,* Slough, Bucks

Mr M.E. *Solomon,* Slough, Bucks

Department of Agriculture for Scotland

Mr W.P.L. *Cameron,* Dalkeith, Midlothian

Dr D.W. *Williams,* Glasgow

Dr D.S. MacLagan, Glasgow

Commonwealth Institute of Entomology

Dr F.I. van *Emden,* London

Mr G.J. *Kerrich,* London

Dr T.H.C. *Taylor,* London

Agricultural Research Council

Dr H.F. *Barnes,* Harpenden, Herts

Mr S.H. *Bennett,* Bristol

Dr L. *Broadbent,* Harpenden, Herts

Mr P.E. *Burt,* Harpenden, Herts

Dr G.H.L. *Dicker,* East Malling, Kent

Mr J.A. *Dunn,* Cambridge

Mr J.L. *Hitchon,* London

Dr C.G. *Johnson,* Harpenden, Herts

Dr J.S. *Kennedy,* Cambridge

Dr A.D. *Lees,* Cambridge

Dr C. *Potter,* Harpenden, Hetrs

Dr F. *Raw,* Harpenden, Herts

Mr G. *Samuel,* London

Mr H.L.G. *Strovan,* Cambridge

Mrs Dr M.A. *Watson,* Harpenden, Herts

Dr V.B. *Wigglesworth,* Cambridge

Dr C.B. *Williams,* Harpenden, Herts

Mr D.W. *Wright,* Cambridge

Association of Applied Biologists

Dr H.F. *Barnes,* Harpenden, Herts

Dr J.W. *Evans,* Tolworth-Surbiton, Surrey

The Society for British Entomology

Mr J. *Cowley,* Bridgwater, Somerset

Mr G.J. *Kerrich,* London

Mr E. *Rivenhall Goffe,* Kings' Somborne, Hampshire

The University of Birmingham

Dr E.B. *Edney,* Birmingham

UNITED STATES OF AMERICA

Government

Prof. J. *Chester Bradley*, Ithaca, N.Y.
Dr E.C. *Bishopp*, Washington, D.C.
Dr C.W. *Sabrosky*, Washington, D.C.

The Entomological Society of Washington

Prof. Dr Joseph C. *Bequaert*, Cambridge, Mass

The Entomological Society of America

Dr Curtis W. *Sabrosky*, Washington D.C.

The Lepidopterists' Society

Mr Cyril F. dos *Passos*, Mendham, N.J.

The New York Entomological Society

Mr Cyril F. dos *Passos*, Mendham, N.J.
Mr Lucien *Pohl*, New York

New York Zoological Society

Miss Jocelyn *Crane*, New York

Pacific Coast Entomological Society

Dr Norman W. *Frazier*, Berkely, Cal

American Association of Economic Entomologists

Dr G.N. *Wolcott*, Piedras, Puerto Rico

VENEZUELA

Government

M. *Dagnino*, Wassenaar, Netherlands

Ministry of Agriculture

Dr Harold *Box*, Maracay

YOUGOSLAVIA

Government

Prof. Dr C. *Simic*, Belgrade
Prof. Dr S. *Zivojinovic*, Belgrade
Prof. Dr Z. *Lorkovic*, Zagreb

GENERAL PROGRAMME OF THE CONGRESS

Friday, August 17th

2.00 p.m. Official opening of the Congress by His Excellency Mr J.H. VAN MAARSEVEEN, Minister of Home Affairs of the Netherlands, in the Great Auditorium of the Institute for the Tropics.
Addresses by the President of the Congress, Prof. R. JEANNEL and Prof. N.H. SWELLENGREBEL

8.00 p.m. Social evening in the Hall of the Institute for the Tropics. Premiere of the film: "Glimpses of tropical Insect life, an entomological miscellany" (Kodachrome) by M.A. LIEFTINCK, Bogor.

Saturday, August 18th

9.30 a.m. General session (Great Auditorium). Lectures:
H. ENGEL (Amsterdam) – JAN SWAMMERDAM as an entomologist.
F.S. BODENHEIMER (Jerusalem) – Insect diapause.
B. TROUVELOT (Versailles) et R. REGNIER (Rouen) – La position de la recherche biologique en entomologie appliquée; Historique, développement, perspectives (Presented by R. REGNIER).

12.15 p.m. Photograph of the assembled Congress-members.

2.00 p.m. Meetings of sections.

5.00 p.m. Boattrip through the canals and the port of Amsterdam, invitation of the Municipality.

Sunday, August 19th

10 a.m. Excursion to Groet (whole day).

2.00 p.m. Excursions to Haarlem (dunes), Teyler Museum, and Loosdrecht

7.30 p.m. Dinners of sections.

Monday, August 20th

9.30 a.m. Regular meetings of sections. Symposia in sections nrs. IV, IX.

2.00 p.m. Regular meetings of sections.
Symposia in sections nrs. IX (continued), I.

8.00 p.m. Reception of Congressmembers by the Netherlands Government and the Municipality of Amsterdam in the State Museum.

Tuesday, August 21st

9.30 a.m. Regular meetings of sections.
Symposia of sections nrs. II, III V and VI.

1.00 p.m. Excursions

Wednesday, August 22nd

9.30 a.m. Regular meetings of sections.
Symposia of sections nrs. VII, VIII, X, XIV.

12.30 p.m. Lunch offered to the Congressmembers by the Netherlands Entomological Society in „Krasnapolsky".

2.30 p.m. Regular meetings of sections. Symposia of sections nrs. X (continued), XIII.

8.30 p.m. Demonstrations of films by Congressmembers in the Great Auditorium of the Institute for the Tropics.

nursday, August 23rd

9.00 a.m. Excursions

riday, August 24th

9.30 a.m. Regular meetings of sections.

2.00 p.m. General session (Great Auditorium). Lectures:
P.P.GRASSÉ (Paris) Les castes des Termites et leur determinisme.
C.B.WILLIAMS – (Harpenden, Herts) – The International aspects of Insect Migration and Insect Drift.
Official closing of the Congress.

7.30 p.m. Opera performance in the Municipal Theatre, Leidseplein, followed by supper in "Bellevue", Marnixtraat.

aturday, August 25th

Excursion to the Reclamation works around the former Zuyderzee.
Departure of excursion to Ameland.

unday, August 26th

Excursion to the "Biesbosch"

onday, August 27th

Excursions to Goes and Drente.

1. OPENING SESSION

Friday afternoon August 17th

At 2.10 P.M. the President introduced H.Exc. the Minister of Home Affairs of the Netherlands, Mr J.H. VAN MAARSEVEEN, with the following words:

Mesdames et Messieurs,

Comme Président du IXième Congrès International d'Entomologie j'ai le grand honneur de vous souhaiter la bienvenue à Amsterdam.

C'est spécialement à Son Excellence, le Ministre de l'Intérieur des Pays-Bas, Monsieur VAN MAARSEVEEN, que je voudrais exprimer notre reconnaissance d'avoir la bonté d'assister à cette séance afin d'inaugurer notre Congrès.

Je tiens aussi à faire bon accueil aux représentants des gouvernements qui ont envoyé une délégation officielle à ce Congrès et qui nous font l'honneur d'assister à cette séance d'ouverture, puis au Comité d'Honneur de ce Congrès, et aux délégués officiels d'entomologistes d'une grande partie du monde. Je regrette beaucoup que quelques pays n'aient pas eu l'occasion d'y prendre part.

Et maintenant j'aimerais inviter Son Excellence, M. VAN MAARSEVEEN à prononcer son discours d'inauguration.

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OPENING SPEECH

Delivered by H.Exc. the Minister of Home Affairs of the Netherlands, Mr J.H. VAN MAARSEVEEN.

Le gouvernement néerlandais se réjouit extrêmement de souhaiter la bienvenue à vous tous, qui, de tous les coins du monde, êtes venus pour assister à ce IXième congrès international d'entomologie et pour contribuer à son succès.

Pareilles réunions se prêtent à favoriser l'entente internationale, non seulement dans le domain purement scientifique, mais encore sur le terrain de la cooperation et de la fraternisation du genre humain. En vue de la situation internationale votre présence ici est pour cette raison déjà d'une grande importance.

En retournant chez vous, vous saporterez les impressions de ce congrès, impressions reçues par les rencontres des congressistes de beaucoup de pays et peut-être de notre pays en particulier. Par ce rapport je me permets de vous souhaiter que ces impressions soient excellentes et de saluer particulièrement ceux qui ont été délégués officiellement par leurs gouvernements avec lesquels nous entretenons des bonnes relations.

En premier lieu vous êtes venus ici pour échanger les résultats de vos activités scientifiques. Ceux qui exerçent comme vous la science par l'amour

de la science sont sans doute du nombre le plus priviligié des hommes. Vous pouvez suivre votre penchant pour observer la nature, chercher les lois, qui y règnent, pour expérimenter, pour classer, réunir et comparer les connaissances acquises pour délibérer la dessus, le tout en sachant que vous faites un travail social hautement utile; les résultats pour l'horticulture, l'agriculture et la salubrité publique en sont les preuves évidentes. Ainsi la société profite de votre science et celle-ci à sont tour continue à latir sur les résultats atteints par ceux qui exerçaient cette science exclusivement pour elle-même, sans qu'un rendement profitable se laissait prédire. Il y a toujours une modifications graduelle de la science pure à la science appliquée jusqu'à l'application des résultats de la science dans la société. Et tout ceci peut être atteint quand on laisse faire ceux qui exercent la science et quand on ne les dérangepas dans le jeude leur esprit et de leur imagination. L'activité scientifique n'est-elle pas jusqu'à un certain point une forme plus élevée du jeu?

C'est cette fonction du jeu dans la science que notre grand historien Huizinga indique dans son livre: „Homo ludens, essai de la fonction du jeu", dans lequel il montre la présence extrêmement active et fécondede ce jeu l'avènement de toutes les grandes formes de la vie collective, e.a. la science.

Et – pour m'exprimer d'une toute autre façon – le poête populaire néerlandais Van Alphen n'a-t-il pas dit: „pour moi jouer c'est apprendre, apprendre c'est jouer"? Et, pour rester sur votre terrain, ne connaissez vous pas tous, celui qui entreprenait des voyages entomologiques à l'étranger, le célèbre „Prikkebeen" (en français „Cryptogame"), qui allait en Amérique pour ramasser de sa propre main des papillions? Très connu dans notre pays et de fraîche date est le livre délicatement spirituel de Godfried Bomans, intitulé: „Eric, ou petit manuel d'entomologie".

Dans ce livre le petit Eric, qui dans son rêve est arrivé dans le pays des insectes, a beaucoup d'aventures étranges. A l'école Eric a mis son zèle à apprendre les leçons d'entomologie dans le fameux livre d'un certain Solms. C'est pourquoi il est devenu maintenant l'oracle pour ses nouveaux amis, les insectes. „De tous côtés", ainsi raconte l'auteur, on le questionnait au sujet de la ponte, de l'élévage des larves et de toutes choses plus ou moins connexes. Parfois, s'il se rappelait le chapitre concernant du livre, il donnait une réponse exacte; mais le plus souvent il disait: „Faites comme vous avez fait toujours, alors tout s'arrangera. Et, si c'est pour la première fois, suivez votre instinct. Vous avez tous un instinct, c'est sûr. Solms lui-même l'a écrit. Si vous suivez cet instinct, vous faites exactement ce que Solms a dit. Quand vous pressentez le moment de pondre, faites-le sans crainte, car alors c'est la bonne saison. N'essayez-pas de pondre plutôt ou plutard que vous en avez envie, car alors tout s'embrouille".

Les insectes étaient stupéfaits.

„Alors," „demandaient-ils, nous faisons exactement comme c'est écrit par Solms et tout seul sans l'avoir lu?" „Si, exactement", Eric répondait. Et la nuit, dans sont lit, il pensait: „C'est quand même curieux. Ils sont beaucoup

plus intelligents que moi. Moi, toute une soirée m'occupe pour bien apprendre un seul chapitre, tandis qu'eux, ils font exactement cequ'il décrit, sans l'avoir lu de leur vie. C'est quand même beau qu'un instinct. J'aimerais bien l'avoir".

En vue de ce congrès une même réflexion se présente dans mon esprit. Vous êtes beaucoup plus intelligents que moi, pourtant j'ose vous donner un avis pareil: Suivez votre penchant inné scientifique. Et pour le reste, qu'est-ce-que je pourrais mieux faire que de ne plus vous détourner de vos activités scientifiques, le but de votre arrivée.

Continuez donc vos efforts dans la joie qu'ils vous donnent, dans la conviction qu'ainsi vous contribuez à la prosperité publique et dans la certitude que tout le monde vous est reconnaissant des grands services, que vous ne cessez pas de lui rendre.

Le IXième Congrès international d'entomologie est ouvert.

* * * * *

After the official opening of the Congress, the following telegram was sent to H.M. Queen Juliana of The Netherlands, Patroness of the Congress, in the name of all members:

„Her Majesty the Queen of the Netherlands.

The President and the members of the IXth International Congress of Entomology, gathered in the opening session in the Royal Tropical Institute in Amsterdam, pay their respectfull tribute to Your Majesty and highly estimate your willingness to accept the Patronage of the Congress."

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ADDRESS

by the President of the Congress, Prof. D.J.KUENEN

Ladies and Gentlemen,

One of the great handicaps of all international gatherings is the fact that we do not all speak the same language. Unhappily it has, up to now, been impossible to decide upon one single language, whether artificial or natural, which could be used on such occasions.

We therefore have to use several languages alternatively, which is not a very satisfactory solution, but no other, within our financial possibilities, presents itself. I should very much like to bid all of you welcome in your own language. As that would mean about 30 different languages, you will see that such a project is an utter impossibility.

We have left our own language out of all official proceedings, as too few foreigners know it. Of all other I am sorry I can use only three, French, English and German, all of which at least will be used by representatives of the 40 nations which have joined in this Congress. Though I have some difficulty in bringing myself to use all three, I hope it will show our good intensions in trying to overcome the langugage difficulty as much as possible.

sdames et Messieurs,

Quand on prépare un Congrès international il est toujours difficile de gar- l'équilibre entre les différents aspects d'un tel Congrès. On veut donner membres la possibilité d'échanger leurs idées, on veut leur donner la pos- ilité de faire des conférences, mais on veut aussi leur montrer le travail omologique et puis quelques aspects du pays, du peuple et de sa culture. 'e crains que tout Comité d'Organisation soit tenté de mettre trop de cho- sur le programme et peut-être nous aussi nous sommes-nous rendus cou- les d'une telle erreur.

e fondement de tout Congrès consiste en conférences, aussi bien de ceux sont délivrés pendant les sessions générales que de ceux qui sont déli- s dans les sections. Il s'y présente la difficulté que leur nombre est si nd et que les sujets sont tellement variés qu'on exige beaucoup de la con- tration et de la versatilité des auditeurs.

a concentration donc est une conditio sine qua non pour un bon échange lées. Et ce sont justement ces échanges d'idées qui doivent être la sub- nce essentielle d'un Congrès. Faire un conférence c'est un événement uni- ral qui parfois ne se fait pas valoir dans un programme sur chargé.

ous avons donc essayé de stimuler cet échange d'idées en proposant dans lupart des sections certains sujets à discuter. A cette fin un nombre d'en- ologistes a été invité pour éclairer quelques aspects d'un seul problème. squ'on a fait circuler les extraits de la plupart des conférences, nous es- ns que non seulement les conférenciers, mais d'autres membres aussi se préparés pour la discussion. Nous avons confiance qu'il y en aura beau- qui se donneront la peine de prendre part à la discussion et qui contri- ont ainsi à la réussite des symposia.

uant aux autres conférences, là aussi j'espère qu'on n'hésitera pas à dre la parole, afin d'animer les sessions et de les rendre plus fécondes. s le programme on a réservé suffisamment de temps pour permettre des dis- sions.

algré la différenciation et la spécialisation de l'entomologie, il n'a pas difficile de trouver des conférenciers pour les sessions générales du Con- . Nous croyons avoir trouvé des autorités sur certains sujets dont nous osons que la plupart des congressistes s'y intéressent.

u'on se réalise que, à part de plusieurs périodiques internationaux de ité, c'est le contact personnel aux Congrès qui est indispensable au dé- ment de la science et des savants.

uant aux publications, il est nécessaire qu'elles soient serrées; on pou- donc les malinterpréter. Si elles sont trop étendues, alors en général on e donnera pas la peine de les étudier et pour la plupart des lecteurs l'es- iel se perdra dans la quantité de détails. De ce point de vue composer publication est une des choses les plus difficiles du travail scientifique, equ'elle doit contenir ce qui pourrait être d'importance pour les autres. ne il est difficile de savoir ce qui, dans son propre travail, intéresse au- surtout puisque les uns d'intéressent à bien d'autres choses que les autres!

Certainement dans la science de l'entomologie, comme dans toute la biologie, où l'on s'occupe d'objects vivants – en tous cas d'objects qui ont vécu – , il est impossible de s'exprimer seulement dans des termes tout à fai exacts. C'est donc en général une entreprise hasardeuse que de publier se: résultats.

C'est la conversation avec l'auteur lui-même qui éclairera beaucoup.

Il y a encore une quantité de choses qu'on ne peut fixer par écrit, comm des suppositions, des possibilités, des théories à demi développées et qui n sont pas assez mûres pour la récolte.

C'est toujours quelque chose de définitif, d'irrévocable qu'une publication bien qu'il paraîsse qu'on ait de plus en plus l'habitude de publier des donnée incomplètes et par conséquent trompeuses ou même fausses, sans assez de restriction. Mais ce sont justement ces sujets-là qu'on peut par excellence introduire dans les entretiens, comparer aux opinions d'autrui et faire mûri ainsi à la lumière de l'esprit d'un autre qui s'occupe de problèmes semblables.

Enfin il y a l'aspect de l'appréciation de la personnalité. Non seulement ce qu'on écrit et la manière de le faire est la mesure de la qualité du travail. Il est rare que ce caractère sorte de l'écrit. Lorsqu'on rencontre alors l'auteur on appréciera mieux son oeuvre et un résultat plus effectif pour l'étude de la littérature en sortira.

Créer la possibilité de telles conversations c'est une des fonctions essentielles des Congrès internationaux. Nous nous figurons que, non seulement entre les sessions et pendant les excursions, mais surtout pendant et après les diners des sections, on aura l'occasion de s'entretenir à son aise. Qu'on profite autant que possible de cette opportunité.

Meine Damen und Herren,

Ein internazionaler Kongress eignet sich besonders für Exkursionen und Besuche an Institute. Wir haben eine ziemlich grosse Anzahl Exkursionen in in das Programm eingefügt und aus den zahlreichen Anmeldungen geht hervor, dass diese grosse Auswahl den Wünschen der Kongressteilnehmer entspricht.

Die Entomologie in den Niederlanden ist ziemlich stark differenziert sei es auch dass die verschiedenen Sparten nicht alle gleich stark entwickelt sind. Es gibt aber auf manchem Gebiete Wertvolles zu sehen und wir hoffen, dass Sie nicht ohne Erfolg Ihre Besuche an unsere Institute machen werden.

Auch unsere Landschaft hat seine Eigentümlichkeiten. Wir haben versucht Ihnen während der Exkursionen einen Eindruck der verschiedenen Landschaftsarten, die charakteristisch für die Niederlande sind, zu geben.

Erstens gibt es die Dünen, dieser Streifen von Sandhügeln, der die Entstehung der Niederlande ermöglicht hat und der zugleich die wertvollste Verteidigung gegen das Meer bildet.

Zweitens die Polderlandschaft, die sich hier entwickelt hat in einer Masse, wie sie sich sonst nirgendwo auf der Welt findet, und wo der grösste Teil des niederländischen Volkes seine bedrohte Existenz führt, durch Deich und Pumpe gesichert.

Und schliesslich unsre Sandgebiete, wo Heide und Wälder noch einen kleinen Ueberrest zwischen den Kulturfeldern behalten haben und wo die Stadtbewohner sich bisweilen von der täglichen Arbeit erholen können.

Vielleicht werden auch einige von Ihnen Gelegenheit finden sich dort einen Augenblick von den Anstrengungen des Kongresses auszuruhen.

Ladies and Gentlemen,

It would seem that there is little in common between the taxonomist studying a family of Coleoptera, an ecologist interested in the age at which a certain Lepidopteron may produce eggs, a chemist trying out the result of an additional methyl-group in an insecticidal formula, the physiologist estimating the rate at which a stimulus passes along the nerve of a cockroach or the medical entomologist counting the number of Anopheline mosquito's in houses of some remote village.

The obvious answer, that they all study insects, would seem hardly sufficient reason in itself for coming together in an Entomological Congress.

The Entomologist of the old days, he who knew almost everything known about insects, no longer exists, not because the present day generation has less spacious brains, but because there is too much to be known. Specialisation has become necessary in entomology too, and there is perhaps no part of biology where the divergence has attained larger proportions than just here.

It has been suggested that there is a relation between the variation within the group of insects and the variation of entomologists. If this were the case there should be similarity in this differentiation. It is easy to show that this is not the case.

Insects are a systematic group, and as a group they contain an incredibly wide amplitude in their morphology, physiology and ecology. If we compare them with any other group of Arthropods, or with Echinoderms of Vertebrates this immediately becomes obvious.

We have stopped wondering at the difference in way of life of a Termite queen and a Dytiscid larva, the adult Microlepidopteron and the myrmecophilous Paussid, the parasitic Hymenopterous larva and the littoral Staphylinid. Each group of insects attains near perfection in adaptation to nearly all possibilities of animal life on earth, the sea being a very remarkable exception, where insect life has hardly penetrated at all. It is sometimes difficult to trace back recent morphological characteristics to the more conventional aspect or to suggest the lines along which certain forms and functions have developed in the course of time. But in spite of this all insects retain certain fundamental qualities which are characteristic of the group. And whatever freaks they become, they always remain a balanced entity, in equilibrium with their surroundings. The moment they are no longer such a balanced entity they cease to exist.

The differentiation in the group of entomologists, on the countrary, shows itself to be of a very different nature, and in no way parallel to this.

The entomologist is interested in a certain group of features which are pr sented by insect life. He does not study a group with a certain differentiati in all its aspects, but certain aspects of a smaller or larger group. This do of course not apply to the same extent to all entomologists, but we all suff more or less from this shortcoming. Let me give you two examples.

Certain taxonomists are interested in the external morphology of a group insects, and generally this would be an order or a family. They seem som times to forget that they are studying physicochemical entities and that t morphological characteristics are only one aspect of something much mo fundamental. The number of spines on the middle femur are but a sympto but they are not themselves what marks the difference between one speci and another. The difference lies in the physiological, embryological and g netical facts which cause the difference, and the biological facts which a caused by it. Obviously they are very convenient and probably the most i portant characteristics to be able to distinguish between two species. Th value, but also their limitation becomes very clear the moment two speci no longer can be distinguished on morphological ground. We then get t well-known physiological and ecological races. These terms constitute t last attempt to restrict specific differences within the realm of morpholog It appears that no essential distinction can be made between specific diff rence on morphological or physiological grounds. Two groups differing in t kind of food they will take and can digest are as much two species as tho differing in a morphological characteristic. Surely here we must confess t we have not yet found the external difference which is correlated with th physiological difference.

We may also take an example from the group of „economic entomologists

The fact that one insecticide applied under certain circumstances ki about 50% of a group of insects in a certain condition, and that a change any of the circumstances changes the result, is in itself an important fa but it does not help to build up entomology. To do so this observation shou be investigated in its physiological and perhaps histological aspects as in doing a loose fact could be incorporated into a larger conception of the li of an insect.

I do not suggest that every insecticidal test should be treated in this w but the entomologist doing this work should realise that he is performing p siological experiments of a rather complicated nature and that he is constan leaving things undone. When working with this in mind he might organise h experiments in such a way that others can use his data and material bett without detracting from the value for his own research. In the long run th will give him also a better understanding of what he has been doing.

But the economic entomologist in the field is also, sometimes unwitting performing ecological and genetical experiments. By applying an insectici to a certain area he changes the circumstances of the world in which anim and plants live. This is done with only one aim in view, but a great many ot things happen at the same time. In many cases this has been called upsetti the balance of nature. The fact that we are cultivating plants in large are

of the same age and variety, and in a highly artificial medium, is in itself erious upsetting of the balance of nature. Ploughing, fertilising, regulation :he water-table and weed-control constitute as many changes in the habitat all plants and animals living there. But it is important to put on record that ; unnatural balance of culture in many cases still retains some of its regu- ory mechanism which can be destroyed by the injudicious application of ecticides. It shows how little we realise the adaptability of animal life to nged circumstances, and how little we know of what is happening around under our very noses.

Large scale ecological experiments by economic entomologists, not rea- ng what they were doing, have led to results serious for agriculture, though resting for the ecologist. Has they realised what they were doing, they ht have been more careful.

At the same time these applications are large scale genetical experiments Each time an insecticide is applied a certain number of animals are kil- which changes the genetical composition of the population. In many cases results have not become evident yet, but where the development of resis- strains has occurred, this shows us what we can expect if this goes on h longer. The fact that the animal organism can adapt itself to this very tural change in the environment, such as the addition of DDT, Leadarse- , hydrogencyanide or some other insecticide, gives us perhaps the most ing example of what unknown resources ~~in~~sects have in store, The warning ld not be taken too lightly. Our very existance is to an ever increasing ee becoming dependent upon the successful control of insects, and at ent chemicals constitute the mainstay of the system. A different approach, g into account the more fundamental knowledge of insects as a basis, in future stave off the approaching catastrophe in agriculture.

et these examples be sufficient to stress the necessity for working to- er.

is a pity that too many of those who would willingly do so lack the time ve their full powers to these problems, as there is no doubt that all concerned would benefit by a better integration of our knowledge.

e physiologist should know the ecologists problems, and should take the le to find out what to other is worrying about. He may be able to help ith suggestions and he will certainly find problems there worthy of his to be solved.

e geneticist should study the work of the economic entomologist who unexplainable" results in his tests, and try to help him solve his pro- . This should be coordination of work and not subordination. No specia- hould be afraid to take up a suggestion from another worker for fear of ing considered original and independant. In helping others to solve their ms with his own technique and way of thinking his contribution to science even greater.

tomy, so much neglected in these times, will yield very important re- and can for certain types of workers perhaps be made more attractive

when the connection with morphological and physiological features is stresse and the necessity of anatomy as a basis for the advance of these branches (science is made clear.

And finally we should find the taxonomists who are willing to use any da available for distinguishing between species of insects whether they be mo phological or not. It is for obvious practical reasons necessary that the iden tification of insect species, as of any other animal or plant, should be poss ble on museum-specimens. This means that morphological characteristic should always remain the basis for identification, and probably classificatic also. But the choice of the characteristics for this taxonomy should not b made on morphological grounds only, but on biological in the widest possibl sense. In that way systematics might become what it should be: both the bas for and the crowning achievement of the combined efforts of all those who c rightly call themselves entomologists.

I sincerely hope that with such an idea for guidance we may still succee in keeping entomology a unity not only joined by words but by thoughts a aims. Only then will there be sufficient reason to come together in Entomolc gical Congresses, which have been such a success in the past and whic should remain so in the future.

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ALLOCUTION
du nom des délégués étrangers, par le Prof. R. JEANNEL

Comme en 1948, à Stockholm, je me trouve désigné pour prendre la parol au nom de tous les entomologistes venus des diverses contrées du mond pour prendre part à ce Congrès. J'en suis un peu confus, car je vois dan cette salle bien des collègues éminents qui auraient été plus dignes que mc d'occuper cette place. Je me suis incliné devant le désir de notre Comit d'organisation.

Nous voici donc, après trois années, réunis de nouveau pour le IXe Congrè international d'Entomologie, et cette fois à Amsterdam. Mon premier devoir au nom de tous les entomologistes dont je suis le porte-parole, sera de salue Leurs Excellences les Ministres de l'Education, de l'Agriculture, de l'Econ mie et des Affaires Etrangères qui ont bien voulu patronner notre Congrès ainsi que tous les Savants hollandais qui ont accepté d'en constituer le Cc mité d'Honneur.

J'adresse aussi mes plus affectueux compliments au Dr K. JORDAN, presiden d'Honneur des Congrès Internationaux d'Entomologie. C'est lui qui en a ét le fondateur et depuis les débuts, il n'a cessé de mettre toute son activité sa compétence et son inlassable dévouement au service de leur bonne orga nisation. C'est par un juste témoignage de reconnaissance que nous l'avon élu, il y a trois ans, notre président d'Honneur à vie. Tous ici, nous somme heureux de le voir parmi nous, pouvant être fier de la bonne continuation d son oeuvre.

C'est enfin notre éminent Président, M. le Professeur KUENEN que je salue respectueusement au nom de tous les congressistes ici présent. Ses travaux l'ont mis au tout premier rang parmi les entomologistes du monde entier, et nul n'était mieux qualifié que lui pour présider à nos travaux.

Au nom de tous encore, j'adresse à M. le Dr DE WILDE, Sécretaire Général du Congrès, et à nos collègues de ce pays l'expression de notre reconnaissance pour l'accueil amical qu'il nous font en étant si nombreux autour de nous.

Trois années se sont écoulées depuis notre dernière réunion. Avant que s'ouvrent nos séances de travail, au cours desquelles tant de sujets importants seront mis en discussion, il n'est pas inutile de jeter un regard d'ensemble sur les progrès faits en entomologie depuis notre dernier congrès, et aussi de souligner certains points au sujet desquels il est permis de manifester quelque inquiétude.

Après la fin de la grande tourmente de la guerre, qui a bouleversé le monde entier, il a fallu des années à tous les peuples pour se ressaisir, pour refaire toute l'organisation de la recherche scientifique dans la plupart des pays. On peut constater aujourd'hui, avec satisfaction, que notre science a repris son essor d'autrefois et est entrée dans une ère nouvelle de production scientifique accrue.

On ne peut s'empêcher d'admirer l'activité des Républiques sudaméricaines, dont les publications entomologiques vont rivaliser dorénavant avec celles de notre vieux monde. Le nombre et l'importance des travaux sortant des Universités nordaméricaines s'accroissent sans cesse, et la même progression se manifeste dans la production entomologique de la Grande Bretagne, des Pays Scandinaves, de la Belgique, de la Hollande, de la Suisse. En Allemagne, nous commençons à voir paraître de gros ouvrages d'ensemble, comparables à ceux qui ont fait honneur aux éditeurs de jadis. Dirai-je encore qu'en France, sous la Direction du Professeur GRASSÉ, ici présent, un nouveau Traité de Zoologie est en cours de publication et que ses trois gros volumes sur les Insectes, qui viennent de voir le jour, marqueront une date dans l'histoire des progrès en entomologie.

A constater cette abondance de publications qui enrichissent nos bibliothèques, il semblerait que l'entomologie soit vraiment entrée en période de grande prospérité dans tous les pays du monde. En réalité, de graves difficultés subsistent.

La cherté du coût de la vie limite de plus en plus l'activité des amateurs, qui sont de moins en moins nombreux dans nos Sociétés. Et celles-ci ne peuvent pas élever suffisamment le tarif des cotisations pour équilibrer leur budget de publication, car les prix des travaux d'impression ont augmenté et augmentent sans cesse dans des proportions désastreuses.

Cet état de choses sévit un peu partout, mais surtout dans les pays à monnaie dépréciée, comme la France, l'Italie, l'Autriche. Les Annales de leurs Sociétés entomologiques, les Revues autonomes n'arrivent plus à trouver les fonds nécessaires pour imprimer des travaux de quelques centaines de pages,

malgré les subventions qu'elles reçoivent des organismes nationaux de re cherche.

Certes, l'entomologie n'est pas seule à en souffrir, Les difficultés son les mêmes dans toutes les branches des sciences, quoique surtout dans le sciences naturelles. Il serait souhaitable qu'un organisme international, com me l'ONU, dont une des activités majeures est de développer la culture dan le monde, consacre des fonds importants à subventionner les publication scientifiques dans les pays qui en ont le plus grand besoin et sont d'ailleur ceux qui ont toutjours été en tête de la production scientifique mondiale. Po développer la culture, ne faut-il pas d'abord lui donner les moyens de s'ex primer? Mais il faut constater qu'aucune branche de l'UNO n'envisage cett manifestation de son activité. Il est triste de devoir dire que nos Congrè internationaux, eux-même, ne reçoivent plus les quelques milliers de dollar qui leur étaient autrefois versés pour couvrir les frais d'impression de leur dompte-rendus.

Mais laissons là ces préoccupations et mettons nous au travail. Nou sommes tous séduits par la méthode nouvelle selon laquelle le Comité d'or ganisation de ce Congrès a preparé nos séances de sections. Le fait d'avoi mis, pour chacune, une question d'intérêt général à débattre, va leur donne plus d'éclat. La Hollande, de tous temps, a été le pays de la plus grand liberté de pensée. Elle reste dans sa tradition en nous mettant à même d'ex poser les idées les plus contradictoires. Mais il est certain qu'il sortira d nos discussions des mises au point qui préciseront l'avancement de recher ches effectuées séparément dans nos divers laboratoires.

Et puis, pour conclure, laissez-moi dire avec quelle joie nous nous trou vons tous ici réunis dans la Hollande, ce pays des grands travaux de défens contre l'envahissement par la mer, ce pays des fleurs, ce pays dont l'hospi talité est devenue légendaire, ce pays enfin dont les admirables trésors ar tistiques rassemblés dans les Musées demanderaient bien plus d'une brève semaine de Congrès pour que nous puissions en apprécier tous les charmes.

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After this, Prof. N.H. SWELLENGREBEL delivered his lecture titled EXPANDING SPECIALISM (see: Lectures given at the Plenary Sessions, p.1).

2. PLENARY SESSION

of Saturday morning, Aug. 18

The following lectures were given:

1. H.ENGEL, Amsterdam: JAN SWAMMERDAM as an Entomologist (see p. 11)
2. F.S.BODENHEIMER, Jerusalem: Arrested development and arrested activity in insect life (see p. 21).
3. R.RÉGNIER, Rouen & B.TROUVELOT, Versailles: La position de la recherche biologique en entomologie appliquée. Historique, Développement, Perspectives (see p. 41).

3. CLOSING SESSION

Friday afternoon Aug. 24

1. Lecture by P.P.GRASSÉ, Paris: Les castes des Termites et leur déterminisme (see p. 51).
2. Lecture by C.B.WILLIAMS, Harpenden: The International Aspects of Insect Migration and Insect Drift (see p. 63).

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3. After the scientific part of the closing session was finished, the President read a letter from the Secretary of H.M. the Queen of the Netherlands, expressing the appreciation of Her Royal Majesty for the telegram sent at the opening session. He also read a telegram from the All Union Entomological Society of the USSR, explaining that this Society had been unable to send delegates and sending best wishes for a succesful Congress.

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4. RESOLUTIONS RECOMMENDED BY THE EXECUTIVE COMMITTEE. Presented by Dr N.D. RILEY.

On behalf of the Executive Committee I have first to bring the following resolutions to the attention of Congress. The Committee recommend

a. That the present Executive Committee be known henceforth as the Permanent Committee

b. That in future no life subscriptions of any kind be accepted

c. That all institutional life subscriptions be terminated forthwith

(The above resolutions having been put to the vote of Congress by The President, and agreed, Mr. RILEY proceeded:)

Since the Stockholm meeting of the Congress, the honorary membership has suffered through the loss of several of its distinguished members. Dr IMMS, Dr MACGILLAVRY, Dr SILVESTRI and Dr RIMSKY-KORSAKOV are no longer with us, and we mourn their loss. The Committee recommends that one very well known and ever present figure at our Congresses, an entomologist distinguished in many fields, and former Director of the Paris Museum, be now elected an Honorary Life member, namely Doctor JEANNEL.

(The recommendation was accepted with acclamation)

The Permanent Committee has received from the Secretariat of the International - Congress of Phytopharmacie a suggestion that the Entomological Congress should so arrange their programmes as to avoid over-lapping and duplication of work in fields that at present are common to both. In these days, when International Congresses seem prone to multiply with great rapidity, any arrangement that tends to simplify and coordinate their relationships needs careful study. The Committee will therefore ensure that this request shall be brought to the attention of the organisers of the next Congress. With

regard to the next Congress, the Permanent Committee finds itself in a difficult situation. Prior to our meeting here, only one invitation had been received. During the past few days invitations have reached the Committee from several sources. In particular a most attractive proposal has been submitted from South America. The result is that the Committee finds itself unable at the moment to submit a definite recommendation, and would beg leave of the Congress to be allowed time to examine these proposals in greater detail, and to accept in the name of Congress the invitation that seems to it best suited to further the progress of international co-operation in the entomological field, It will use its best endeavours to obtain an early decision.

With regard to the date of the Next Congress, the Committee very strongly recommends, for a variety of reasons which I need not now discuss, that it shall be four years hence, namely in 1955.

Congress having agreed to the recommendations of the Permanent Committee, in respect of the next Congress, Dr KUENEN stated, in reference to an interruption by Dr CARVALHO, that the invitation specifically mentioned was indeed from the Government of Brazil.

5. RESOLUTIONS PRESENTED BY MEMBERS OF THE CONGRES

The following resolutions were accepted with acclamation:

a. Resolution from Sect. IX (Forest Entomology), presented by Dr A.D. VOÛTE:

To forest entomology an understanding of the regulation of the population density of insect pests is necessary. To reach this understanding more fundamental research is needed concerning the mechanism of regulation. Correlations between the measured population density and the measured differences in environmental conditions cannot give a sufficient explanation of this regulation. They may however suggest the lines on which future research must be done.

b. Resolution from Sect. X (Tropical agricultural Entomology) presented by H.J. DE FLUITER:

Considering that workers on biological control problems feel hampered administratively by a widespread notion, unsupported by scientific evidence, that this method gives better results on islands and is therefore more suited for insular than for continental areas in the tropics,
this section resolves that our knowledge of the fundamental facts underlying succesful biological control of insect pests is insufficient to enable categorical statements about the relative merits of the method in insular and continental areas to be made.

This situation should be rectified by intensifying basic research on biological control in the tropics.

c. Resolutions from Sext. XI (Insects in stored products), presented by Mr G. VAN ROSSEM:

a. The Section appreciates the excellent programme of excursions provided or the present Congress, but asks that the following suggestions shall be assed on to the Committee responsible for the arrangements for the next Con ress. That is in drawing up the programme of excursions the interests of sto- ed product and household pest entomologists should be kept in mind and ar- angements made for visits to warehouses, grain silos, food factories etc., articularly where control methods can be demonstrated, e.g. circulatory fu- igation plants.

b. The Section suggests that the title of the Section should be altered to: Stored Product and Household Insects".

he Section would then deal with insect pests in factories, restaurants and ouses. Insects attacking timber would still be dealt with in the Section „Fo- est Entomology", and insects biting man and animals in the Section „Medi- al and Veterinary Entomology".

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. After this, Prof. V.B.WIGGLESWORTH addressed the Congress with the following words:

I have been asked to say a few words of thanks to our Dutch hosts, who ave all done so much to make this Congress such an outstanding success. ou may wonder why it is that I should have been called upon to undertake is pleasant duty. The reason is simple enough: the members from Great ritain form our largest national group, outnumbering even the delegation from e Netherlands themselves; and I happen to be a delegate from the Royal ociety of London, which is the premier scientific society in Britain. That is Society for which I believe the Dutch have a kindly feeling, for it was the oyal Society which published those wonderful letters from ANTHONIE VAN EEUWENHOEK.

This Congress has been a remarkable success. It seems to me that is has en a family affair, the growing family of Western Europe and all her rela- ons. We are, of course, a very mixed lot of people: ce qui n'est pas clair 'est pas français; was nicht etwas dunkel ist, ist kein echtes Deutsch; and hat is absolutely serious is not really English! But we have got on well gether.

We are grateful in the first place to yourself, Dr KUENEN who have held the ief command as president and have done so much to create this friendly at- osphere. You have been most ably assisted by your four divisional comman- ers and our warmest thanks are due to them: to Dr DE WILDE for his magnifi- nt organization; to his assistant Mr DE JONG; to Dr KRUSEMAN for his outstan- ng skill in marshalling our excursions; and to Mr FISCHER who, as commander the pay corps has had perhaps more troubles than you all. Then there were out thirty battalion commanders – I cannot name them all – who gave much lp as sectional recorders; the women's auxiliary corps in the reception offi- under the command of Miss SCHIPPERS; and those outstanding units of bio- gical students of Amsterdam and Leiden with their wonderful telephone stem. We owe much, also, to the technical staff in this Institute and the di-

verse laboratories we have visited. And I must not forget to say a spe word of thanks on behalf of the ladies of the Congress to Mrs TEN CATE all the other members of the Ladies Committee for their untiring work. Fi ly we should express our thanks to the unknown designer of the this most tistic congress badge. We shall all treasure it as a memento of a very ha week.

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7. VALEDICTORY ADDRESS
by the President of the Congress

Ladies and gentlemen,

It now remains for me to close this Congress.
Before doing so I should like to thank all those who have spoken at gene and sectional meetings for the trouble they have taken, and also those w by taking part in the discussions, have helped so much in making Congress a succes.

When a Congress is a success, it is sometimes attributed to the Preside when anything goes wrong, it is always the fault of the Secretary. I want stress once more the fact that what success this Congress has had, is due the first place to the untiring efforts of Dr DE WILDE. Of the others I will o mention the two students C. GROOT and H.A. VAN SEVENTER who we responsible for so many of the minor details and who so ably led the ot guides in their work.

UVAROV studied locusts and discovered the phenomena of phases. We ha now been able to see the same phenomenon in Entomologists.

There is no apparent morphological difference between the groups but p siologically they are quite distinct. Contrary to the situation in locusts, t control of the gregarious phase at Congresses is much more easy than that the solitary. These last tend to spread and only with great difficulty can th be captured and induced to stay where they should.

It is especially when worms swoop down on their feeding places that t gregarious habits become most obvious. In this case the bait was not inte tionally poisened, and as far as I am aware most of the participants survive

Also those interested in migration must have found much to occupy the attention, But, like bees, entomologists tend to return to their, be it temporar homes in the evening. A few stragglers, attracted by the bright Neon-light may have stayed out somewhat longer and little is known of the fate. Ultim tely, however, they returned safely.

The ecologist will have noticed how the microclimate was influenced l the presence of the swarms, and in particular the section for Tropical agricu ture will have found these gatherings a fitting environment for their meetings.

The acceleration of metabolism may have worried certain physiologists b they are, no doubt, capable of thinking of subsiduary theories to explain the reactions.

Seldom will a swarm of invaders have been received with such pleasure and will their departure have been watched with equal sorrow as in this case. Every outbreak leaves its traces and this outbreak of entomologists will leave them in the Netherlands. But the ravages left here will be excellent food for our minds. They have created an excellent environment for further growth of entomologists in the Netherlands young and old. For having created this environment we are very grateful to you and my final words must be: thank you for having come here.

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LECTURES GIVEN AT THE PLENARY SESSIONS

EXPANDING SPECIALISM

by
N.H. SWELLENGREBEL
Amsterdam, Netherlands

The title of my lecture, expanding specialism, is a contradiction in terms: specialism is associated with shrinking. The word reminds one of a legendary artist, a painter, who sought to express the idea which existed in his mind as the prototype of the perfect shape. One after another he discarded the elements he formerly had considered essential to his art; his pictures became more and more geometrical, detached from all human interest. Finally he believed to have penetrated to the core of his problem; but the result did not become known till after the artist's death. Then he was found, with a beautified expression still lingering on his face, in front of his last picture, the apogee of his artistic conception. – It showed a perfect circle.

The point I wish to make here is that there is more in specialism than meets the eye in the tragic scene of the painter's death. The term expanding specialism intimates that specialism may be more than the sustained interest in one single subject; that it may transgress the limits of the familiar "knowing more and more about less and less".

All will agree that science has grown to such an extent that no one can follow doctor Faustus's example of being well versed in all branches of science. In these days no zoologist will be called a specialist because his knowledge of botany has never been re-stocked since his student days; not even if his interest centres in one of the main subdivisions of the animal kingdom, as does the entomologist's. But the entomologist who devotes himself to Coleoptera, to the exclusion of all other insects, may be justly classfied as a specialist.

What prompted the student of entomology to take up a particular specialism?

The desire to collect is a great motive power. Perhaps it is so no longer, but it certainly was in the past. It played a notable part in DARWIN's training, but he got over it. In some naturalists it is a permanent trait. And if, in addition, the craving for completion gets hold of them, some may become like collectors of postage-stamps, who turn from the whole world to the Union of South Africa, and from the Union to the Old Colony, urged by the desire to possess a complete collection. That is shrinking specialism. I do not propose to identify collecting of insects with collecting of postage-stamps, but they have certain features in common; if no other, it is this that both collect objects which have no life in them.

The search for beauty is another inducement. It leads the artistic mind to certain groups of insects. That mind will value beauty more than complete-

ness, and thus its possessor may be saved from the shrinking of his specialism. But he will require a sound scientific training, otherwise his sense of beauty will lead him astray.

Things are different if collecting is no longer the main object. In that case the group of insects which are the object of specialisation must show some unusual feature in order to command the sustained attention of the investigator. The genetical importance of *Drosophila,* for instance, may have lured him into specialising in one single genus. But he will be rewarded by the subsequent expansion of his specialism, owing to its close association with genetics. Other groups of insects invite to specialisation by the relationship, existing between these insects and human society; and that relationship, in its turn, may become the cause of the specialism's expanding.

My intention is to discuss an instance of the latter kind, which shows how expanding specialism may originate; and the directions in which it may expand. That instance is an extreme form of specialisation in dipterology (itself a specialism), the object is the genus *Anopheles.*

The origin of this specialism is obvious: the relation to human disease of some members of this genus; the disease concerned being mainly, though not exclusively, malaria.

As an introduction I may be allowed to call attention to some fundamental facts, well known to science.

ROSS's discovery that malaria was transmitted by dappled-winged mosquitoes, and GRASSI's identifying them as *Anopheles,* although of fundamental importance, was of comparatively small practical value, because generalised mosquito destruction was not feasible at that time. STEPHENS and CHRISTOPHERS laid down the foundation for a practical application of ROSS's discovery by showing: (1) that some anopheline species carry malaria while others do not; (2) that each species of *Anopheles* has its own particular breeding places. Finally WATSON, following STEPHENS and CHRISTOPHERS's lead, put their rules into practice, and thereby succeeded in controlling malaria by eliminating the breeding places of one anopheline species, and deliberately leaving six others alone.

This completely changed the situation. The application of ROSS's discovery had become a practical proposition. Henceforward every plan of malaria control had to be based on the answer to three questions: (1) Which are the species of anopheles indigenous in the area to be protected? (2) Which of them is the principal malaria vector? (3) Which are the breeding places of the vector?

These are the basic facts. It will be noted that it all hinges on species; so much so that WATSON's method of malaria control has been called species sanitation, because it aims at hitting one species only. These species were collected, identified and classified according to the rules of the art. Prob-

lems as to whether a species was a species, a subspecies only, a mere variety, or nothing at all, were likewise settled by universally accepted laws. The study of *Anopheles* in no way differed from that of any other genus known in entomology.

That was true up to a certain point – and no farther. For the species were not represented by mounted type specimens, to be compared with specimens in another collection, for the sake of settling their claim to the dignity of species-hood, on the merit of a black spot on the anal vein, or of fused spines on the dorsal lobe of the harpago. – On the contrary, they were represented by live specimens, to be tested on characters unknown to classical entomology, such as cocysts on the stomach, or sporozoites in the salivary glands; the origin, human or animal, of the ingested blood; feeding habits: indoors or in the open, by day or by night; range or flight; type of breeding places; mating habits.

Nevertheless, taxonomy remained of the utmost importance. Before dissecting an anopheles, to see if it carried sporozoites, one had to make sure to which species it belonged; and that, of course, could only be done by the morphological characters of the adult female. To ascertain whether the vector-species had a marked preference for a particular kind of breeding place 4th instar larvae had to be identified on the strength of their chaetotaxy. Thus it came about that the removal of the preferential breedingplaces of the vector-species, for the sake of malaria control, was considered justified on no firmer basis than that of morphological characters, which were not necessarily heritable characters. So a heavy responsibility rested on the shoulders of the specialist.

In Museum-zoology a dead and mounted animal is considered the type of a new species, if it differs sufficiently from related forms, and if the gap separating the prospective new species from previously known ones is not filled up by intermediate forms. This criterion of a valid species is not enough when one intends to deal with malaria by the method of species sanitation. For the application of this method one condition must be fulfilled: the species to be destroyed must remain the same in succeeding generations, it must breed true to type. The Museum criterion does not guarantee this.

As it is, however, the species of *Anopheles* do not even come up to the Museum standard. Save for the sub-genera *Bironella* and *Brugella,* all *Anopheles* are so much alike, that the differences between the groups and series: *Myzorhynchus, Anopheles, Myzomyia, Pseudomyzomyia, Neomyzomyia* and *Neocellia,* are just sufficient to satisfy the demands of the more exacting type of species maker. There were zoologists who refused to admit the validity of most anopheline species; they considered them as non-heritable modifications or, at best, as the products of Mendelian segregation.

What this meant to the anopheles specialist can best be explained with reference to the *Pseudomyzomyia* group of anopheline mosquitoes.

Round about 1916 the Indonesian members of this group bore the species of *ludlowi, rossii,* and *indefinite.* In the island of Java *ludlowi* bred in brackish water along the sea coast; so did rossii, but it also bred in fresh water; indefinita bred in fresh water only. *Ludlowi* and *rossii* were numerous in highly malarious areas; rossii and indefinita also occurred in much less malarious areas. Wherever *ludlowi* and *rossii* bred in the same locality, the adults of both species could be captured in human habitations: *ludlowi* infected with malaria parasites; *rossii* not infected. Farther inland, in fresh-water regions, where *rossii* and *indefinita* were the only representatives of the *Pseudomyzomyia* group, they were not found infected, not even in malarious regions. So all data pointed to *ludlowi* as the vector-species along the coast, and to *rossii* and *indefinita* as poor carriers. Since *ludlowi* bred in brackish water only, the application of species sanitation, in this particular case, meant the elimination of the brackish breedingplaces, to the exclusion of the fresh-water ones. That would control *ludlowi*, and malaria, while leaving the unimportant *rossii* and *indefinita* more or less completely unharmed. Dealing with the brackish breedingplaces might be a difficult and costly business, but much less so than dealing with the fresh breedingplaces in addition to the brackish.

That was one side of the picture. The other was the doubt cast on the validity of the three species of the *Pseudomyzomyia* group; a doubt which paralysed antimalarial activity by rendering illusory the principle of species sanitation. What is the use of killing *ludlowi* while granting life to *rossii* and *indefinita*, if the three are really one?

The *ludlowi* problem was solved by a bold stroke; by assuming that the species would locally disappear with the local disappearance of its particular breeding places; that it would not take on the biological character of its next of kin, that is: breeding in fresh water; and that its next of kin would not take ludlowi's place as a malaria vector. All this was not only taken for granted, it was acted upon by carrying out a huge and costly experiment, Costly, that is, if it was unsuccessful; if it proved a success it would amply reward the expenses by the improved health of the population. But no one knew with any degree of certainty if it would be successful.

Local conditions were like this.

The breeding places of *ludlowi* were extensive shallow ponds near the sea shore, filled with seawater with a varying admixture of fresh water. In these ponds bandeng, clupoid sea fishes, are raised. Big specimens, fetching high prices in the market, feed on algae covering the water of some ponds. A poorer quality of fish, cheap, and therefore a highly desirable addition to the diet of the lower classes, is reared in ponds devoid of surface algae. *Ludlowi* and *rossii* are mainly breeding in the algae-covered ponds, as the mat of algae protects the larvae from depredation by minnows. Thus, some ponds supply the poorer classes with much needed animal protein; others are economically valuable; and so none of them can be missed. On the other hand

the ponds are the most prolific breeding places imaginable, and so it is imperative to do away with them. The specialist was saved from this dilemma by a method which became known as hygienic exploitation of the fish ponds.

The principle of the method was that the fish ponds were dealt with in a way so as to render them unsuitable for the growth of surface algae and, consequently, for the breeding of *ludlowi.* The exploitation commenced in a limited area, extensive enough, though, to counteract infiltration of *ludlowi* from outside the area. *Rossii* was partly effected, indefinita not at all, neither were any other anopheles breeding in the region. The outcome of the experiment was that *ludlowi* was proved to be a reliable species. It did not change its habits, as had been anticipated, by beginning to breed in fresh water, it simply disappeared. *Indefinita* and *rossii* did not begin transmitting malaria, they remained uninfected. Malaria was greatly reduced after some years.

That, however, can be left aside, as irrelevant to the point at issue, which is this that the *Anopheles*-specialist in pursuance of his studies had been compelled to extend them far beyond their original confines, so as to include items such as incidence and quality of malaria, social and health conditions of the population, technical and economical aspects of fish trade. But in following these apparently devious routes he never lost sight of his ultimate object: the systematic status of *ludlowi*, not in the taxonomic but in the biological sense, as a species breeding true to type, and fit for control by species sanitation.

The result, whatever its merit by solving the local problem, could not inspire general confidence, because it was inexplicable. How can this species keep separate from closely related species? The *Pseudomyzomyias* are so much alike; their adults, males and females, meet every night in human habitations; even if they were species, originally, they cannot fail to loose their purity by miscegenation, and to produce various Mendelian recombinations. No signs of the existence of such recombinations were encountered in the experiment, although it lasted for several years. But anopheles which might have been products of Mendelian segregation, resulting from crosses between *ludlowi* and *rossii*, were found in various parts of the Indo-Australian region. In the island of Sumatra a fresh-water *ludlowi* was known, as potent a vector as the salt-water type. In the Philippine islands the species also breeds in fresh water only, but there it does not transmit malaria. In the Malay Peninsula salt-water *ludlowi* was considered a vector of doubtful importance in 1913. And, to complete the list of possible combinations of the *ludlowi*- and *rossii*-characters, *rossii* was reported a malaria carrier in the south-western part of the island Celebes.

Experiments in Holland, within the limits of the same specialism, and prompted by the same motive, the application of the principle of species sanitation, went a long way to relieve the doubt resulting from the above considerations.

Apparently species sanitation cannot be applied in Holland; for all in-

tents and purposes there exists one species of *Anopheles* only. However, there is an inexplicable discrepancy between the distribution of malaria in the two littoral provinces of Norht Holland and South Holland, and the distribution of Anopheles throughout the two provinces. Malaria is largely confined to North Holland; *Anopheles* are numerous in both provinces, all belonging to the species Anopheles maculipennis. In Indonesia it was accepted as a broad rule that the geographical distribution of a malaria vector roughly coincides with that of malaria. If this coincidence was absent, the incriminated anopheles, if not freely acquitted, got at least the benefit of the doubt. Applying this rule to Holland would lead to the absurd conclusion that no malaria vector exists in the country.

A close inspection of *maculipennis* in N. and S.Holland brought out the fact that the Southerns are slightly longer than the Northerns. As the length was expressed by quoting the length of the wings, the Southerns were called "longwings", and the Northerns "shortwings". The breeding places of *maculipennis* are predominantly brackish in North Holland, and mainly fresh in South Holland. So it was believed at first that the shortwings were weaklings, suffering from breeding in salt water; the longwings, breeding in fresh water, were normal *Anopheles*. Pursuing this line of thought, it was assumed that the weaklings were more susceptible to malaria infection than the stronger longwings. Thus the deleterious effect of salt water in North Holland rendered anopheles a good carrier of malaria in that province; and fresh water influenced inversely the *anopheles* of South Holland: they were strong mosquitoes, but poor carriers.

Continued research showed, however, that longwings and shortwings breed true to type through succeeding generations, independent of external conditions. Furthermore, longwings were also found in North Holland, where they were a small minority owing to the scarcity of fresh water. Although they were never found infected with malaria parasites, not even in villages where shortwings were found infected in large numbers, they could readily be infected in the laboratory. Thus it was proved that the absence of longwings infected in nature is not due to an innate, or acquired, insusceptibility to malaria infection. Subsequent investigations brought out the fact longwings fail to become infected in nature because they cease to take blood in late summer, just at the beginning of the season most favourable to the infection of anopheles.

And now the moment has arrived to repeat the question which could not be answered in regard of the *Pseudomyzomyias*: how can the longwings and the shortwings be kept from crossmating? They roost in the same buildings during the period of sexual activity; they feed on the same animals, including man. It is only in late summer that they part company; then both cease to produce eggs; the longwings seek shelter in outhouses where they enter upon a period of hibernation; the shortwings keep near to man or domestic animals where they continue to take blood.

Can longwings and shortwings interbreed? On the face of it, it seemed

likely enough. However, their mating habits were found to differ considerably. Shortwings copulated inside cages, even in very small ones, including test tubes plugged with cotton wool. In confinement longwings refused to mate with their own kind, even in cages of 30 cub.ft. But they occasionally mated with shortwings, even in cages of ordinary size; thereafter eggs were laid, and from these eggs larvae were hatched. If the mother was a longwing none of the larvae lived over four days. If the father was a longwing it took 36 days before the last larva died. This is the answer how longwings and shortwings keep themselves pure, although they are so much alike and live in so close association. A double sexual barrier separates them; (a) their different mating habits; (b) the non-viability of the hybrid larvae. Combined these barriers render cross-mating extremely unlikely.

On the strength of these findings malaria control in the province of North Holland has been carried out, since 1936, according to the principles of species sanitation. Not, however, by dealing with the larvae in the breeding places of one species only, but by spray-killing adult mosquitoes, nowhere but in sites known to be the haunts of infected shortwings, and at no other time than that when malaria is rife among these mosquitoes.

And now the return to the *Anopheles*-specialist's field of observation in the Indo-Australian Region. The findings in Holland, proving the reliability, not of two species, but of two types of one species, did much to remove the doubt about the validity of the long-established Indonesian species.

But that was not enough. The rule that the area of distribution of the vector-species coincides with that of malaria had broken down in Holland. There the explanation was that the vector-species was composed of two independent groups; one group was the vector, the other was not. In Indonesia the rule broke down on more than one occasion, and this has initiated a revision of the species concerned. This revision in its turn has led to the creation of new subspecies and varieties. Contrary to what happened in Holland, most of them are based on morphological characters only, and it is doubtful if the evidence borrowed from Holland can be stretched to the point of justifying their existence. Two examples of this kind may be quoted.

The first is the old species *ludlowi*. Several types of this species occur in the Indo-Australian region. As has been said before, they once were regarded as the result of Mendelian segregation following crossmating between *ludlowi* and *rossii*. They are so no longer. On morphological grounds the Philippine type, breeding in fresh water, is regarded as a separate species, for which the name *ludlowi* has been retained. All others are now called *sundaicus*. There are no morphological characters warranting the creation of further subdivisions. But it has been found convenient to distinguish between: (1) salt-water *sundaicus* and (2) fresh-water *sundaicus*, the latter restricted to the island Sumatra. The group of fresh-water *sundaicus* has been subdivided into: (a) fresh-water *sundaicus* of fish ponds, as occurring in one district, and (b) fresh-water *sundaicus* of rice fields and grassy swamps, occurring in other districts.

Fresh-water *sundaicus* of fish ponds merits special attention, and for the following reason. The fish ponds it bred in were surrounded by rice fields during one season, and by grassy swamps during another. Removal of the fish ponds, advocated as a measure of malaria control, was expected to result in *sundaicus* going to breed in the rice fields or grassy swamps, as it was known to do in other districts. Nevertheless the fish ponds were expropriated and converted into rice fields, at a cost of £ 40,000. As a result *sundaicus* did not resort to the surrounding breeding places; it simply faded away. And so did malaria after some years. As a side-issue the experiment proved the fresh-water *sundaicus* of the fish ponds to be a reliable species from a public health point of view. As to the other subdivisions of the former species ludlowi, including the Philippine subdivision still bearing that name, they must be regarded as provisional, as their validity has not been tested experimentally.

The second example is that of *Anopheles hyrcanus*. It is a wide-spread species, ranging from Southern Europe and Africa to Indonesia and China. It is known by a number of names, supposed to represent as many species and subspecies. But the genetical status of these subdivisions has not yet been investigated. It was universally regarded as harmless in the Mediterranean region, Africa, India and Indonesia. In 1920, however, it was proved to be a carrier of malaria on the East Coast of Sumatra. This happened under somewhat unusual circumstances, which were the following.

In the early years of the present century the tobacco and rubber growers of Sumatra's East Coast had succeeded in eradicating beri-beri among the labourers on their estates. This had been accomplished by supplying them with a diet mainly consisting of unpolished rice, instead of the highly polished rice which had formerly been their principal food. During the first world-war supplies of unpolished rice ran short, and it had been necessary to revert to polish rice. That caused a renewed incursion of beri-beri. In order to prevent a repetition of this unfortunate coincidence, the tobacco growers took measures to grow rice on their estates. That implied laying out wet rice fields. Wet rice fields were known to breed *A. hyrcanus* in large quantities. Thus the species, already common in the region, was expected greatly to increase in numbers; but that did not cause any undue concern. This sense of security was rudely shaken when the expected not only happened, but also brought an entirely unexpected malaria epidemic in its wake, with *A. hyrcanus* as its only vector.

This experience forced the planters to abandon the attempt. Moreover it drew general attention to *A. hyrcanus*. Soon evidence was accumulating, pointing to that species as a common malaria vector throughout the interior of Sumatra. At the same time considerable discrepancies became apparent between the distribution of malaria and hyrcanus. In some areas there was no doubt about its being a vector, in others there was ample evidence that it was not. A close analysis of Indonesian *hyrcanus* revealed the existence of a number of groups characterised by differences in their taxonomy. One of

them was found more closely associated with malaria than any other. This may in time prove the solution of the *hyrcanus* problem, when breeding and crossmating experiments have supplemented taxonomic data.

All these instances are illustrations of expanding specialism. In each one of them the specialism, without loosing its character, in fact by its very nature, is linked with wider interests. In the examples quoted here these wider interests are primarily human interests, related to the betterment of health. But while investigations are developping, these interests come to include social activities, like agriculture, animal industry and civil engineering, as well as sciences, like parasitology, pharmacology, genetics. The specialist does not turn to them in order to rest his mind by change of occupation, but because he clearly perceives that they are essential to his work, which cannot be completed without them.

However, he will not be able to see this, unless he keeps an open mind to the human aspects of his specialism. So long as he realises that he is responsible to his fellow-man, just because he is a specialist, so long his specialism will go on expanding.

I have limited my subject to one specialism in entomology. I am well aware of the existence of expanding specialisms in other fields of that science, and in other sciences. Moreover, I fully realise that the motive power causing specialism to expand includes more than interest in man's wellbeing. In fact, I believe that on the highest level of mental activity expanding specialism is inspired by the vision created by the birth of a fundamental scientific theory, as was DARWIN's specialism of the Cirripedia. But only the few select will attain to that height.

Let me conclude with this remark:

There is a tendency nowadays to depreciate specialisation. For my part, I believe this tendency in no way called for. We need not regret specialism. On the contrary, we ought to welcome it – if only it keeps expanding.

JAN SWAMMERDAM AS AN ENTOMOLOGIST

by
H. ENGEL
Amsterdam, Netherlands

"Though the bloodless animals may seem very unimportant in the eyes of most people, they deserve the same admiration and accurate examination as the other creatures, since they were created by and from the awe-inspiring Hosts of the All-Wise and Formidable Maker" – thus SWAMMERDAM in his dedication to the Burgomasters of Amsterdam of his Historia Generalis Insectorum.

It was in 1669 that SWAMMERDAM wrote this dedicatory letter to the Burgomasters. In their session of January 7, 1670 they decided to let him have a grant of two hundred guilders for this book. Did they know that the appearance of the book meant a landmark in the history of biology, that the fame of its author would surpass by far that of their own temporary glory? In any case, we may praise them for their wisdom and insight in furthering their citizen's scientific aims by allowing him in their session of a fortnight later to investigate the human corpses in the municipal hospital and by this their financial contribution to the publication of this book.

Both are necessary: the temporal maintainers of the goods acquired by individual and society, and the "unpractical" idealists who despise the temporary attainments of their time and with their thoughts reach far beyond to the eternal sources of all that is true, good and desirable.

Is not this the place to remember the successors of these old seventeenth century burgomasters, our present municipal government? Who in wisdom and benevolence have supported this our meeting of idealists as far as the present difficult times allow. Idealists, who work with their thoughts in the clouds and their eyes on the smallest and seemingly most insignificant animals, satisfy their inherent thirst for knowledge and their inborn need for admiration. Idealists, yes, in as far as they seem to live in a world far from that of the man of practical and matter of fact knowledge – extremely practical men, however, in as far as their cryptic activity has proved to be of the utmost importance for the wellfare of human society.

We know that TOPFFER's "M. Cryptogame" (in Dutch "Prikkebeen") for most people is the prototype of the entomologist: a short-sighted prier for the smallest animals, which he carefully collects, pins into his top-hat first and then arranges in boxes with the same zeal as the postage stamp collector. Though "M. Cryptogame" had not been created yet at his time, BOERHAAVE in his biography of SWAMMERDAM already enumerates the different, remote and often curious places where the entomologist chases his prey by night and by day, viz. air, water, earth, land, fields, meadows, waste lands, dunes,

riversides, beaches, rivers, stagnant waters, lakes, sea, wells, herbs, rubbish, holes, houses, yes, even privy closets.

Times have not changed very much since then. There has been, however, a slight development in the appreciation for the entomologist's practical importance. How would old SWAMMERDAM have felt when he could have attended the present Congress? Certainly he would have felt at home with so many congenial people from all over the world, all devoted to his ideal, the study of the smaller creatures. He would have tried to double or treble himself to attend to all the interesting meetings, he would have absorbed with avaricious thirst for knowledge the many achievements since his time, he would be astonished to see and hear our microscopical and chemical results. With special interest he would study those on the development of his little animals and be satisfied to see that he was right in maintaining that no miraculous metamorphosis but simple outgrowth reigns the development. In many cases he would find a really wonderful increase of knowledge, but in others he would be astonished to see that but little has been added since he studied the insects with his penetrating zeal, curiosity and accuracy. As he puts it in his "dedication", he would find that his "investigations served as the firm foundation on which a larger and more wonderful structure was built – as a torch to discover inexpressible truths, which hitherto had been darkened under the falsehood of unreasonable feelings". But he would also find, as he puts it in the introduction to his famous study on the development of the May-fly, the "Ephemeri vita", that one man's life passes as ephemerously as a day; that in many respects man has only little developed since he, SWAMMERDAM, made his studies, about 300 years, being about five times a man's lifetime, ago.

We could also ask, supposing that he had lived till now, whether he himself would have developed and would agree with our separating things profane and things divine, acknowledging that it is impossible to study nature without that deep feeling of relationship, that boundless admiration for its wonders and that unfathomable love for our fellow-beings, which is the source and fountain of the entomologists' curious occupations. Would he admit that it is not necessary to spice each entomological publication with quotations from the Holy Scriptures, or would he despise us for our idle occupations and invite us to make an auto-da-fe of all the results at the end of our Congress?

We may smile at it, but here we touch one of the most interesting psychological problems with which the student of SWAMMERDAM is confronted. Is he to be considered as a religious maniac at the end of his life? A maniac he was – as far as his absolute devotion to the study of nature is concerned – as we are all more or less maniacal perhaps in that respect. But nobody can hold that he had lost his reason: he simply pursued his inborn curiosity for the secrets of nature as he understood this curiosity and translated it into words: i.e. the attempt at understanding the Source of all secrets, the Creator. First he tried to achieve this understanding through His creatures, but, according to his violent and impatient nature, he at last

tried, true to his character, to penetrate into the Source itself.

He hoped to be taught the method by ANTOINETTE BOURIGNON, but – and this proves his not having lost his reason – he leaves her when she cannot give him what he is seeking.

Without this vehement and piercing nature he would never have achieved what he has now done for us in the few ephemerous years that he passed on this earth: laying the foundation of modern entomology. We may rightly call him the first, and one of the few, great General Entomologists.

Jan SWAMMERDAM was born February 12, 1637 as a son of the apothecary Johan Jacobsz SWAMMERDAM, who had his shop here in Amsterdam near the Montalbaens Tower. At present, alas, this house, not far from REMBRANDT's house, is in very bad state, though a stone indicates it as the birthplace of one of our greatest scientists of the 17th century. It would, by the way, be the ideal place for a museum on the history of our science.

SWAMMERDAM's father had a private collection of rarities, including minerals, fossils, plants, animals, artistic curiosities and coins. It was here that he developed his interest in nature. His father intended him for the Church, but he embarked upon the study of medicine, only to be diverted from it by his passion for entomological research. Finally, however, he completed his medical course and graduated M.D. at Leyden in 1667. Before graduating he had visited France, where he was befriended by Melchisedec THEVENOT, former ambassador, who had a circle of friends, which later-on developed into the Academie des Sciences. Here he continued his entomological and anatomical investigations. On returning home he participated in the foundation of the private Amsterdam "College" of medicine. He was thus for the time committed to human and vertebrate anatomy, and experimented with methods of injection, inflation and preservation. Later, he applied the injection method to the smaller invertebrates and succeeded in filling the blood vessels of a Lepidopterous larva from the heart by means of a capillary glass tube.

After an illness (malaria), SWAMMERDAM was sent to the countryside, but, instead of relaxing, he gave all his time and attention to the study of the insects. At last his father penalized the neglect of a profitable profession by cutting off supplies. To mollify his angry parent, SWAMMERDAM wasted much time in cataloguing the family museum. His shy and retiring nature, the feeling that he could accomplish a scientific task of which he was more capable than anyone else, made him look for a "higher" excuse for his occupations. He turned to theological interpretations of his scientific results under the influence of a fanatic woman, Antoinette BOURIGNON. Yes, even in a vague feeling of guilt he convinced himself that the pursuit of learning was vain. Nevertheless, his scientific interests could not be suppressed and it was during this period of strife and turmoil even that he completed his classic treatise on the honey-bee and the may-fly, working bare-headed in the scorching heat of the sun, so that he could have the full benefit of its light.

The study on the may-fly was published 1675, with extensive theological commentaries, before he dies February 17, 1680, from exhaustion at the age of 43. The MS of the honey-bee and other ones passed into the hands of THEVENOT, who died before he could publish them. After some vicissitudes, they were bought by BOERHAAVE, who published the complete work by SWAMMERDAM on the lower animals under the title Biblia Naturae, in 1737-38, a century after SWAMMERDAM's birth.

No portrait of SWAMMERDAM is known to exist. The one reproduced again and again as such is a forgery based on a figure in REMBRANDT's Anatomy Lesson of Professor TULP, the portrait of the surgeon Harmen HARMENSZ.

The methods employed by SWAMMERDAM in his finer dissections were, according to BOERHAAVE, a dissecting microscope with a series of simple lenses and very delicate dissecting instruments (especially scissors), which he made himself under the microscope. According to COLE he probably was the first to make dissections under water, and to clear up an entomological preparation by dissolving out the fatty substances. The modern practice of preparing Lepidopterous larvae by pressing out the viscera and inflating and drying the skin was invented by SWAMMERDAM, who often also injected them with wax.

His first entomological publication was his "Historia Generalis Insectorum" of 1669. Like the treatise on the may-fly, his second entomological publication, of 1675, it appeared in the Dutch language. Of the first, five other French and Latin editions were published, of the second two, in English and French respectively. Both were included in the Biblia Naturae.

The MMSS are preserved in the Leyden University Library. The beautiful plates show the accuracy and art of their author.

It is impossible to give an account of all the important discoveries included in SWAMMERDAM's work. It forms the foundation of our modern knowledge of metamorphosis, structure and classification of insects, and, moreover, contains valuable contributions to the knowledge of spiders, scorpions, crustaceans, molluscs, worms, the frog, etc.

One of the most complete and important parts is that on the anatomy of the honey-bee. In this first comprehensive account on the subject he proves by dissection that the "king" is the mother of the colony, that the workers are neuters, while the drones are the males. His treatment of the life history and of the work in the hive is very accurate, and so is the description of the mechanism of the sting. He described the structure of the simple and the compound eyes and even found the minute tracheae in the latter. Of the beautiful description of the intestines that of the genitalia is the most interesting. He describes and figures the ovarian tubes of the queen (which he calls the king), the paired common oviduct, the vagina, the bursa copulatrix and the spermatheca. COLE, who carefully compared his description with our modern monographs, found that nothing had been overlooked in the minute

dissection of the male genitalia – an accomplishment which sufficiently proves the ability of SWAMMERDAM.

As it is impossible to give in detail all the discoveries and observations collected in the Biblia Naturae, these few examples may suffice to give an idea of his accomplishments in the fields of anatomy, physiology and biology.

SWAMMERDAM, however, also deeply influenced the speculative biology of his time.

In 1651, William HARVEY had published his "De generatione animalium" and given expression to his deep conviction "Ex ovo omnia" (All creatures come from an egg.) He had, however, made an exception for the lower animals, for which he allowed for spontaneous generation or a sort of metamorphosis out of other forms, comparable in a certain way to the marvellous and mythological metamorphoses described by OVID.

It was to these lower animals that SWAMMERDAM turned his attention. He found that the principle of their development is no other than in the higher animals or in the plants, viz. a simple outgrowth or budding of the limbs and other parts of the body (which he calls epigenesis) and no marvellous metamorphosis of matter.

To understand his conceptions, it will be necessary first to know exactly what he means by these words metamorphosis and epigenesis, because later on both have been used in quite another sense.

Metamorphosis to him is a real change in the whole structure, outer and inner, as when the flies arise from the dead body of an ox. This would mean a sort of miracle and to this conception it is that SWAMMERDAM as a naturalist is opposed. He tries to show that everywhere in nature we see a growing out of preformated parts, as it is observed in the buds of trees, in the young chicken, in the tadpole and in other vertebrates. It is the same in the smaller animals, only more difficult to observe. It is the weakness of their hearts, he says, that hinders them to grow to a larger size. For, it is the heart that distends the body against the opposing pressure of the air.

As in the buds of the trees it often is possible to detect the future leaves, thus in the chrysalis of an insect the future insect may be found, hidden from view by an outer skin, which has to be stripped to permit the further outgrowth of its limbs or wings. There is no real metamorphosis or transformation.

"It is no more curious", SWAMMERDAM says, "than when a despised and down-trodden herb of the field begins to protrude and, swelling into a bud, laughs to her mild Grower with a gracious flower after the bud has burst open".

Again and again he emphasizes the fact that it is no sudden change in form, no transmutation or metamorphosis, but simply a budding or outgrowth,

a slow and gradual, "natural" change of form, which he calls epigenesis.

In the pupa we find an outgrowth or budding of the organs of the butterlfy, till at a given moment the skin bursts open like the bud of a flower and the organs become visible.

He criticizes MOUFETUS who in his well-known Theatrum Insectorum had said that the head of the silkworm becomes the tail of the moth and the tail the head, and that the same holds true for all butterflies. The pupa was considered no real animal, having no mouth (as ARISTOTLE already remarked), but something between one animal, the caterpillar, and another, the butterfly. This SWAMMERDAM denies. GOEDAERT is rebuked for an other mistake. He believes to have seen that the dorsal side of the caterpillar becomes the ventral side of the butterfly.

HARVEY, again, following ARISTOTLE, considered the pupa a species of egg, an "ovum perfectum". He had given another, though related, definition of the words metamorphosis and epigenesis. According to HARVEY there are two possibilities: either there is no increase of building material, the mass of the ultimate animal is not larger than that of the initial quantity of matter, or there is an increase in material while the animal grows out to its final form and size. He compares the former to a block of marble or wood which the sculptor or wood carver metamorphoses into a statue, the latter, however, with the statue which is built up out of clay by adding the material gradually in the places where it is wanted. The former he calls metamorphosis, the latter epigenesis. Metamorphosis is, according to HARVEY, found in bloodless animals, where the worm consists of the same quantity of material as was contained in the egg, as the butterfly consists of the same quantity as the caterpillar that changed into a chrysalis. But in the bloodless animals there is a gradual increase of material as they grow into their final form.

A consequence hereof was that in the bloodless animals the material would be the main principle directing growth, the form being impressed on it like the seal into the wax; hence they are less perfect. In the blooded animals, however, the formative principle is at work and attracts the material and builds it into the definite form. Thus far HARVEY. As many words, adds SWAMMERDAM, as many untruths. But he at once excuses HARVEY, saying that he probably never studied the lower animals himself. According to SWAMMERDAM epigenesis, a gradual and natural growth, is the only way, in which all animal form is fashioned. The formation of the lower animals is often simple and clear and thus a key to that of the higher ones, he says.

He further emphasizes the fact that when the building of the form would be strongly influenced by the material from which it is made (HARVEY supposed that lower animals might generate from putrefying matter), chance, arising from the accidental presence or absence of certain substances, would play a great part. According to SWAMMERDAM, however, there is no chance. All has been predisposed, all growth follows innate laws, there is no change and there is no chance. The predisposition makes the animal grow inside the

old skin, which then is cast off, so that the insect can show itself in its perfect form. And, even when one would think that the ultimate form is not yet present, it in reality is. SWAMMERDAM opened a chrysalis and found the butterfly ready under its skin, he opened a caterpillar before its last shedding of the skin, and found the chrysalis ready inside the skin. What then takes place? The ultimate form is there already from the beginning, preformated though not visible, in swollen form, which he suggests needs drying or consolidation only to become visible.

His ultimate conclusion then is that everything is preformated, be it not in a visible form. And so, he continues, it is not necessary to suppose that, according to a very old pre-Aristotelian (Hippocratic) theory, seed from every part of the body gathers in the male genital organ to compose a perfect seed for propagating its form as perfectly as possible: no, the ultimate form is there already. Thus it is that a man without arms and legs may procreate a healthy child. Hence the later generations were in principle already present in the loins of the first human couple and thus obviously the original sins have been propagated. SWAMMERDAM in this connection quotes the text of PAUL's epistle to the Hebrews Chapter 7 verse 9-10: "And as I may so say, Levi also, who received tithes, payed tithes in Abraham. For he was yet in the loins of his father, when Melchisedec met him".

When we try to understand SWAMMERDAM here, we should make sure first of all that he did not mean it as materially real as the people who saw a homunculus in a spermatozoon, neither absolutely "potentially" or "ideal". Yet he supposed, so to say (though he rebuked ARISTOTLE) that the *morphe* was present in the egg, though not expressed visibly in the outer form. But, though the outer form was un-differentiated to the eye, it yet was potentially the same individual as the full-grown, adult animal, just like the child is the same individual as the adult man, or the young wingless bird the same when it is adult, feathered and winged, though the stages differ in the outer form. It is the same animal that first is a caterpillar and then grows wings, there is no real change or metamorphosis of the outer form, but simply an outgrowth or epigenesis, at first under the skin, then, after its shedding, outwardly visible. At first the limbs are "watery" and cannot be moved, later-on they dry, become stronger and can be used. His main point is that there is no accidental metamorphosis into a new form, but "natural", i.e. naturally caused, growing of the same animal from one form into the other. When studying these things, we must never forget that the conceptions and problems often differed from ours and only gradually developed into the present ones.

SWAMMERDAM's arguments are really meant to defend the modern standpoint that there is no wonder, no marvel, no accidental change in natural growth, but only a continuous development, determined by the original special disposition of the egg. He rebukes HARVEY only because he allowed for a wonder in the lower animals. In these, as in the higher animals, there is continuity, they arise from eggs. The eggs have a definite predisposition

determined by the mother from which they came. It is in defence of continuity, of determination, that SWAMMERDAM opposes against some accidental "metamorphosis". We use the word metamorphosis in a different sense, but we agree with SWAMMERDAM in his opinion that it is determined by the special disposition of the protoplasm in which it takes place.

The same holds true of his "epigenesis". This is the general term for determined growth. How this determined growth takes place, is another question. SWAMMERDAM only uses the fact that the butterfly's wings are present in the pupa or even already in the last stages of the caterpillar, to prove that it is the same individual, that there is continuity.

Only later-on his suggestion has been elaborated in the well-known "Einschachtelungstheorie", the theory of encasement. SWAMMERDAM never says that he believes in a real encasement ad infinitum. He only consistently argues that when growth is determined, the definite form at least potentially must be present in the younger stages, there must be a certain "preformation" of the substance, a specific arrangement of the matter which causes the egg to grow out into a special adult form. That this may take place by a process of drying (the adult legs e.g. being present originally as much swollen parts of the body), is only meant as a tentative suggestion of how the process of outgrowth or epigenesis might take place. It is only later-on that this suggestion of SWAMMERDAM was taken quite litterally, that scientists supposed the whole animal to be really present in miniature; by a process of litteral unfolding or "*evolution*" the preformated small animal developed into the adult. It was then, in 1759, that WOLFF introduced the term *epigenesis* again, but in a more restricted sense, as the growth of undifferentiated tissue into a definite form and as opposed to the then general conception of *preformation*.

The word *epigenesis* for SWAMMERDAM conveyed quite another set of ideas than for WOLFF. The word *evolution* for WOLFF had quite another meaning than it acquired later-on in DARWIN's time. The word *preformation* to SWAMMERDAM simply meant a predisposition; he was too intelligent to take it as literally as WOLFF's contemporaries did, though of course his theories contributed towards this development of ideas.

More important, however, are the systematical conclusions which SWAMMERDAM derived from his studies on insect metamorphosis, metamorphosis in our present sense of the word.

He distinguished four groups. In the first group, the animal emerges in perfect form from the egg. The development or growth from invisible though essential parts to a perfect young animal takes place in the egg, as in spiders and lice. In the second group, the larva emerges imperfect as a worm, which gradually grows legs; it reaches its perfect stage after a series of moultings as in locusts, dragon-flies and may-flies. In the third order, the larva passes a pupa stage, as in bees, beetles and butterflies. In the fourth order, which resembles the third, the larva does not peel off the last skin, as in certain flies. We should not blame him too much for including many

non-insects in the first order. The taxonomy of the lower animals was only just in its beginning. Moreover, SWAMMERDAM was not concerned with morphology but tried to bring more understanding in the field of ontogeny. His aim was principally to show that all these different modes of development were essentially the same: the perfectly emerging insects have to pass a series of moultings before reaching the adult stage; they pass, so to say, their pupa stage in the egg. When the larval stages last long, the adult animals often live only very shortly, their only work being the propagation of the species: all energy has been spilt in their growth. SWAMMERDAM compares this to the weights of a clock. There is only a certain amount of energy. which can be used only once; when it is used in one process, it consequently causes the other processes to be shortened. We see that there is a strong mechanistic tendency in his explanations.

But, beside this his contribution to the science of biology in general, we must consider SWAMMERDAM also the father of modern *taxonomy*, for it is principally on metamorphosis that he built his system – as we do.

I have given only some of the most salient features of SWAMMERDAM's life and work, but I hope to have shown to you, that in this town it is fit to commemorate first of all the man who may be said to have laid the foundations of modern entomology, who – through entomology – strongly influenced the growth of biological thinking in general, insisting on a more logical, causal explanation of phenomena, who first laid down the principles of modern insect taxonomy and who by his accurate observations and logical reasoning may be said to have been our first great insect biologist.

ARRESTED DEVELOPMENT AND ARRESTED ACTIVITY IN INSECT LIFE

by
F.S. BODENHEIMER
Jerusalem, Israel

1. Quiescence in the animal world

The most conspicious difference between the sleeping and the quiescent organism is the difference in the sensory threshold especially in relation to the speed of reactivation, in addition to basic changes of metabolism in the quiescent in contrast to the sleeping organism. Even semi-quiescent animals move sluggishly for hours or days when sudden exterostimulation returns them to activity, if such is observed at all. This is true for bats, tortoises, beetles, a.o.

Dormancy is known since long in seeds and buds of plants, in the cysts and spores of protozoans, in the gemmulae of freshwater sponges, the blastophores of *Bryozoa*, the quiescent wintereggs of many freshwater crustaceans, *Rhabdocoela*, *Rotatoria*, mites, etc. Adult encystation is known from nematods, *Rotatoria, Tardigrada*, etc. of mosses. Hibernation or estivation occurs, apart from many insects, in reptiles, mammals, terrestric snails, lungfishes, amphibians, etc. Seasonal quiescence of gonad activity is well known in mammals, birds and insects, usually effecting the fitting of the birth season into the most suitable season for the upbringing of the offspring. Such adaptations may show either hereditary fixation or be entirely dependent upon, usually unfavourable, exterostimulations, but not necessarily immediately before the beginning of quiescence.

Already ARISTOTLE remarked upon phenomena of insect hibernation. The first modern writers whose comprehensive observations deserve mention are REAUMUR, KIRBY and SPENCE (1818), SCHMID (1808), VAUDONER (1827), and much later BACHMETJEV (1898).

2. Definitions

Diapause was the name originally given by WHEELER (1893) to the resting stage between ana- and katatrepsis, the active phases of blastokinesis in the orthopteran egg. HENNEGUY (1904) extended this originally purely morphological term of embryology to embrace all phenomena of arrested development from the fertilisation of the egg to the last moult. Later students stressed either the factors and conditions inducing or breaking diapause. Some of them used the term in a loose way, equivalent to quiescence, whilst others restricted it to quiescence not broken immediately by favourable exterostimulations. The most elaborate definition has recently been given by SIMMONDS (1948): "Diapause is a state in which a reduction of growth processes or maturation occurs which is not necessarily caused by immediate

environic influences, does not depend for its continuance on unsuitable conditions, and is not easily or quickly altered by change to a more favourable environment. However, once the state of diapause comes to an end, normal growth and development are resumed. Cold, heat, desiccation, excess humidity, deficient or excess nutrition, in fact any wide departure from the optimum conditions for a particular stage of a given species may induce diapause at that time or more usually at a later period of development."

This is a fair phenomenological description of diapause. The difficulties presented by the great physiological diversities of such diapause phenomena may be explained for the egg-development of the Moroccan locust (*Dociostaurus maroccanus;* BODENHEIMER and SHULOV 1951): After the first formation of the germ-band the embryo may arrest its development for up to two months, whilst as a rule development proceeds without interruption. This is a facultative arrest of development. Then development proceeds extremely slowly for 3 to 5 months to a stage following anatrepsis, which development is at the same temperatures ended within one to three weeks in the emergent eggs of related species. This is a definite case of retarded or inhibited development. Finally, about September, when the just mentioned stage between ana- and katatrepsis is reached, development ceases entirely, until inhibaation of water and sufficiently high temperatures, which so far had no accelerating effect upon the speed of development, break whenever they occur combined the diapause, i.e. normally at the end of winter. This last phase had always been called diapause. It definitely is arrested development, but broken immediately upon favourable exterostimulations, which is not the case in the earlier phases. This example well illustrates the difficulties to establish a proper terminology even for diapause of one stage of one species.

Earlier attempts to classify diapause have been mainly based upon one of the three following principles: the stage at which diapause occurs, the factors inducing diapause or those breaking.

The physiology of diapause is still unsatisfactorily known, and as this is the central problem of diapause, any final definiton of diapause (and of its categories) should be postponed until physiology will permit a rational analysis. A difference of basic importance is however that between facultative and obligatory development.

3. *Ecological aspects of diapause*

Under the heading of ecological aspects of diapause we restrict ourselves to deal only with the direct environic effects upon initiation, maintenance and breaking of diapause, but not with those aspects which refer to the vitality of populations, the selectionist and teleological problems of diapause, which will be treated under evolutionary aspects.

Facultative diapause is induced in all cases by environic factors. Even in the majority of cases of obligatory diapause it is induced by exterostimulations, which may have however affected already an earlier, sensitive stage of development of this or even of its parent generation.

Temperature is known since long to be a dominating influence. Yet especially in univoltine species, but also in many others, diapause begins massively to set in at temperatures which often are higher, sometimes considerably higher, than those at which active development in spring sets in. In many cases (*Aphaniptera, Telea*) a progressive trend of lower night minima, in nature expressed as the turning point of the annual temperature curve, determines diapause induction. From Amasia to Rehoboth in the Middle East we can confirm this principle for *Carpocapsa pomonella.* Temperature shocks in the laboratory may have a similar effect. In many insects a prolonged low temperature, which may be replaced by one or more cold shocks, is needed before diapause can be broken at all. In others the exposure to cold storage or to cold shocks speed up considerably the breaking of diapause. In species living in warmer climates this need for cold exposure is rare. For all these conditions good illustrations are found in the egg-diapause of grasshoppers (BODINE, BODENHEIMER). That this need for cold storage is not necessarily connected with a fixed inherited seasonal cycle has been nicely demonstrated by ABELOOS (1935) for *Timarcha tenebricosa,* the egg-larva of which remains above 15°C in the egg-shell, independent of the season at which the egg was laid. Only a prolonged cold can break the diapause and lead to hatching.

Temperatures beneath the threshold of development do not necessarily induce diapause. If the lowest temperatures remain above 0°C, the organism may merely undergo a cold storage. But where hibernation under frost conditions or conditions approaching them occurs, a cold hardiness is induced by previous dehydration and by other changes, which at the same time switch over the metabolism towards that of diapause. At the breaking of diapause, or more correctly at the inset of continued development, environic temperatures must be some degrees above the specific threshold of development. High temperatures also may induce diapause, respectively prevent or retard its inset in its breaking.

Environic moisture is another key factor in diapause. Yet the dehydration preceding diapause is not a mere physical desiccation due to dry environment. It is an independent organismic response to those exterostimulations which induce diapause preparation, which not necessarily must be connected with a dry micro-environment. Drought induces in many cases diapause, as is illustrated well by the great number of estivating species in climates with a dry summer. In practically all cases, studied so far, imbibition with contact water is required for diapause breaking wherever heavy dehydration is characteristic of diapause (cf. grasshopper eggs). In imaginal diapause it is usually the season of succulent vegetation which induces gonad development, probably by imbibition through the intestine.

We will insist here at some length on light as a diapause inducing or breaking factor, as it has been too much neglected, so far. KOGURE (1933) stated that light plus temperature is involved in the induction of voltinism in *Bombyx mori.* SABROSKY, LARSEN and NABOURS (1933) induced rapid

growth and produced a mid-winter generation in *Acrydium angustum* by continuous extra light in moderately warm greenhouses, where without this light the larvae passed the winter sluggishly and without moult. The light, in addition to a moderately high temperature, was needed to break the normal semi-dormancy of hibernation. BAKER (1935) observed that the length of daylight, in addition to favourable temperatures, determines the activation of hibernating mosquito larvae in general. In *Aedes triseriatus*, e.g. at least 12.6 hours of light per day are required for this purpose. De WILDE (1949) noted that in hibernating beetles of *Leptinotarsa decemlineata* permanent light in addition to 25-29°C prevented in many individuals the diapause.

Apparently the only detailed study on the influence of light on diapause is that of DICKSON (1949) on *Grapholitha molesta*. At moderate temperatures (about 24°C) at very short light exposures (26 f.v.) or those of over 14 hours per day during the entire larval stage almost no larvae entered diapause, whilst at 11 to 13 hours daily illumination almost all did so. But at lower (12°C) and at higher temperatures (30°C) almost no larvae entered diapause independent of the length of light exposure. Short daily increases or decreases of length of illumination as compared to a constant illumination showed that the actual length of the photoperiod affects the larva. The photoperiod is more important during the first half of the feeding period than in its later half. Ultraviolet, red and ultrared do not induce diapause, but the intermediate parts of the spectrum do. Low intensities of illumination (0-1 f.c.) did not induce diapause, but those from 3 to 26 f.c. did so highly.

With changes of dark and light periods of equal length from 3 to 15 hours each only those between 10 and 13 hours induced a high percentage of diapause. Alternating cycles of light and day of different length of each category showed that only if the dark periods last 10 to 12 hours daily diapause is induced. Much shorter or longer light periods (less than 6 or above 16 hours) did not induce diapause. Massive diapause of the species in nature sets in when the number of dark-hours passes the critical point for diapause induction. Experiments with short alternating cycles demonstrated, that not the mere ratio of darkness to light, but the absolute length of each in the 24 hours photoperiod is decisive. The photoperiodic effect on the induction of diapause in *Grapholitha* is, following DICKSON, caused by a hormone which is produced by a two-phase reaction during the larval feeding period. The light-induced phase requires not less than 7 nor more than 15 hours per day, and the darkness-induced phase requires not less than 11 nor more than 16 hours per day, to bring the reaction to a successful conclusion.

A similar mechanism exists in *Carpocapsa pomonella*, but in the fly *Lucilia sericata* and in the weevil *Listroderes obliquus* no such light induction of diapause was apparent. Intensive experimentation about light as a factor inducing and breaking diapause is imperatively required. DICKSON has shown the way for the arrangement of such experiments.

Food is certainly an important diapause factor. Thus STRELNIKOV (1936) demonstrated for *Loxostege sticticalis*, that water content in the food

(*Chenopodium album*) of 68% induced diapause for over 10 months, whilst the same host with 85% water content induced no diapause. Also PICTET has collected data in this direction. SQUIRE (1940) referred diapause induction in *Platyedra gossypiella* to the sudden rise in oil content of the cotton seeds. This feeding is admittedly contemporaneous to the increase in fat-content of the larvae previous to diapause. But just as in the case of dehydration this fat-accumulation is not necessarily induced by the food. Thus, the maggot of the winter generation of *Dacus oleae* feeds in olives suddenly rich in oil, but it does not enter diapause. Or, in Israel the local apples mature one to two months before the European varieties. There also the maturing seeds increase in oil content, but the percentage of the larvae leaving the local varieties in April/May entering diapause is not higher than in those larvae which leave at the same time the immature apples of the introduced varieties.

Also in parasitic wasps the influence of food is present. MARCHAL found n *Trichogramma cacoeciana,* that eggs laid into those of diapause hosts undergo diapause together with their hosts whilst those eggs of the same mother aid into emergent host eggs show emergent development. SCHNEIDER showed, that in some Syrphid parasites the diapause behaviour depends ntirely upon that of their hosts. Yet SCHMIEDER and SIMMONDS showed hat in *Melittobia,* parasitic on *Sceliphron*, the quantity or quality of the arval food decides the diapause of the parasite. In all those eggs of the ost which were not parasitised before, no diapause developed, but in all hose which had been parasitised before they did. SCHMIEDER assumes that he former develop upon the haemolymph of the host larva, the later in its issues.

The study of the effect of chemicals upon the breaking of diapause or its revention has almost not yet started. The experience with seeds and buds f plants encourages such experiments, as certain chemicals influence the nzyme activity of the organism and other metabolic processes, thereby leadng to the breaking of diapause. With regard to many other factors the imortant experiments of DUCLAUX (1876) on the effect of shaking, brossing, ectricity, acids, and atmospheric pressure upon the eggs of *Bombyx mori* hould certainly be repeated and extended.

The physiological aspects of diapause

The physiological aspects are, of course, the central problem of diapause. he almost complete switch over in the diapause metabolism is accompanied a number of *preparatory* processes. Among the latter dehydration of the e intermicellary body water, rise of fat content, etc. are widely spread. uring diapause a number of other, biochemical changes take place. Many zymatic activities are interrupted, such as catalase and oxydase (TOWNEND, SPOONER), proteinases (LICHTENSTEIN), and many others, as entioned in the most comprehensive and still uncomplete survey of the g diapause of *Melanoplus differentialis* (BODINE). It was first assumed,

that this change of enzymatic activity be the motor of diapause initiation and maintenance. Today we all agree, that these changes in enzymatic activity are merely concomitant phenomena of the main changes responsible for diapause. Changes in the direction of taxes, such as from positive to negative geotaxis, from negative to positive phototaxis, etc. are observed in connection with setting in and breaking of diapause. They are sometimes, as in the hibernating beetles of *Leptinotarsa decemlineata,* important factors in the change of behaviour, as they are guides in the upward climb of the beetles from the soil after the breaking of hibernation. As similar reversals of taxes are observed in insects with changes of environic temperature (*Trialeurodes,* WEBER 1931), they cannot be regarded as typical for diapause. And recently F. SCHNEIDER (1949) has added the count of the number of heart-beats as a symptom of diapause. We shall discuss here only two physiological factors: hormones and respiration.

The importance of hormones in the development, metamorphosis and gonad maturation of insects has been elucidated in the past two decades, mainly by WIGGLESWORTH, E.THOMPSON, WEED-PFEIFFER, a.m.o. Oenocyte secretion mainly regulates the moults. The role of the corpora allata for growth and metamorphosis is clear, and their role in the maturation of ovaties and eggs has been analysed. All conditions which inhibit the oenocyte cycle interfere with moulting and thereby with growth and development; all conditions interfering with the development of the corpora allata in the adults inhibit gonad maturation. JOLY (1945) has demonstrated this correlation experimentally for *Dytiscus*, E. THOMPSON for flies, WEED-PFEIFFER for grasshoppers, PFLUGFELDER for Coccids, etc. In bees and other social insects insufficient larval nutrition inhibits early ovary development, which is thus unable to provide the needed stimulation for the development of the corpora allata. Thus both remain infantile and induce the formation of neuters.

In *Dytiscus* the massive elimination of nutritive materials from the body by heavy oviposition helps to inhibit the stimulation from the corpora allata for egg maturation during the winter interval, which begins again in the following spring. JOLY's experiments and observations have left no doubt that the so-called imaginal diapause of gonad inhibition or reduction is regulated in the same way by incretory glands, as it is regulated in vertebrates by the pituary gland. This does not mean, that endocrine secretion be independent of environment and of exterostimulations, but merely that the influence is exerted upon the organism through the medium of the incretory glands, in the same way as this is known for vertebrates.

With regard to larval and pupal diapause it is clear, that the freezing of the oenocyte cycle is a concomitant factor (as are other endocrine glands too). With regard to the effect of the environment the same conclusions hold as for the imaginal diapause. Egg diapause is apparently also correlated with hormonal or similar influences, which have however not yet been studied in detail. Certain phenomena of facultative diapause in some parasitic wasps are suggestive in this direction.

The elegant experiments of C.M.WILLIAMS regarding the pupal diapause of *Platysamia cecropia* and related species have added two more endocrine glands to the list of those connected with diapause: a brain gland and the prothoracic gland, each of which secretes one factor. The former is needed for the activation of the second one. The prothoracic factor has ultimate action on the tissues in terminating diapause, whilst the brain is the primary agent. Parabiotic grafting of pupae one of which is in diapause, the other in post-diapause, induces breaking of diapause in the former. This occurs even when the grafted pupae belong to different genera. WILLIAMS states that the endocrine function of the brain apparently involves a sequence of two separate processes. The first process, consisting of a development of competency to produce or release the brain factor, proceeds most rapidly at low temperatures. The second process, the actual release of the brain-factor, proceeds most rapidly at higher temperatures. A mechanism is also evident for relating the endocrinology of diapause to biochemical events at the cellular level, such as the cellular cytochrome system.

It was known since long that the respiratory metabolism of diapause insects is strongly reduced. R.ASHBEL (1927, 1929) made the first comprehensive measurements and comparison of the gas metabolism of the eggs of *Bombyx mori* and the maggots of *Eurytoma amygdali* during diapause and the active stage of egg resp. maggot. Also the Resp. Quotient is much reduced. J.BODINE's sensational revelation of the two respiratory cell metabolism in the eggs of *Melanoplus differentialis*, showed that about 80% of the respiration of the actively developing egg can be blocked by treatment with KCN, whilst no such blocking is observed in the diapause eggs. The blocked respiration belongs entirely to the iron-dependent respiration which is also bound to the integrality of cell structure, whilst the diapause respiration as well as that of the blocked active cell is independent from the presence of iron or an integral cell structure. Whilst the oxydases are blocked, the latter respiration is caused by dehydrogenases. Similar differences have been observed by RUNNSTROM between the respiration of fertilised and non-fertilised eggs of sea-urchins. Needham correlates the iron-bound type of respiration with the exigencies of active morphogenesis. KOZHANTSHIKOV (1938) correlated for all stages of insect diapause cold-hardiness with the increase of the thermostable dehydrase component of respiration. He also showed, that diapause larvae of *Pyrausta nubilalis* are not only cold hardy, but also resistent to asphyxie, as they are able by the utilisation of non-saturated fats to establish an anoxybiontic metabolism. The increase of cold-hardiness after dehydration is correlated with the changes in the type of cellular respiration. AGRELL (1951) observed in diapause pupae of *Phalera* and *Endromis* a reduction of the R.Q. to 0.1-0.3, which cannot be explained by complete combustion of ordinary reserve food, but by transformation of an compound rich in oxygen into another one poorer in it. Injection of aneurin and pantothenic acid into diapause pupae were followed by a definite increase of the R.Q. and of O-consumption, which did not occur in

controls (injection with physiol.sol.). He concludes, that diapause be induced by deficiency of these vitamins, which induces a temporary inability to resynthesize some important compounds.

5. *The morphological aspects of diapause*

The morphological changes in diapause are clearly only an outcome of the physiological ones. This is conspicuous in the gonad inhibition of imaginal diapause. A few cases are known where in hibernating larvae (*Purausta nubilalis;* THOMPSON and PARKER) or adults (*Dytiscidae*; Joly) the gonads are actually reduced to a smaller size. These phenomena, of course, depend upon changes in hormone secretions.

In certain groups the individuals of the hibernating generation are very different from those of the other generations, as in the host-migrating *Pemphigidae* or in the genera *Periphyllus* or *Hormaphis* (HILLE RIS LAMBERS). In the *Psyllidae* the hibernating larvae or adults can easily be recognised by their special tinge of color (SWIRSKI, i.l.). In some cases of seasonal dimorphismus, such as in *Araschnia levana,* one of the seasonal forms is not only connected with cold, but as well with diapause-condition. It appears from a few observations of SHULOV (i.l.), that most emergent grasshopper eggs, when arrested in their development by unfavourable environic conditions, do so in a stage which is approximately equivalent to the stage XIV in which those of *Dociostaurus maroccanus* are arrested and await favourable conditions for further development.

Finally, a few histological observations deserve mention. KATSUKI (1918) has demonstrated that in bi- and trivoltine races of *Bombyx mori*, of *Attacus yamamai* and *Antheraea pernyi* the male germ cells and their nucleus/volume ratio are definitely larger than in the respective univoltine races. FOA (1927) states, that the cells of the germinal stripe of the diapause eggs of *Bombyx mori* are at least as large and possess relatively much larger nuclei in bivoltine than in univoltine races. She supposes that this low nucleus/cell ratio of volume induces a more intensive metabolism, which is also expressed apparently by protogynic hatching in bivoltine, as opposed to the protandric hatching of univoltine breeds. F.SCHNEIDER (1949) has used the relative size of the eyebuds as indicator of diapause in Syrphid-larvae.

The morphological, anatomical and histological aspects of diapause are still little explored and deserve higher attention than has been devoted to them hitherto.

6. *The genetical aspects of diapause*

The genetical aspects of diapause are more complicated than usually is understood. The facts about massive diapause in a definite stage in most insects with one annual generation has lead to the silent assumption, that at least this type of diapause be genetically fixed. This assumption was confirmed by the observation that certain strains of such insects continue to show a complete or almost complete diapause when transferred into areas

where the populations of the same species usually have two or more annual generations.

No such conclusion is possible for all the cases of facultative diapause which undoubtedly are induced by exterostimulations. The only exception are a few cases where homodynamic insects such as ***Phlebotomus papatasii,*** when bred throughout the year in a thermostat, showed a distinct rise in the percentage of diapause individuals during winter. In one series of such experiments the technique of breeding was definitely faulty. Almost every week the electric current stopped during night, sometimes much oftener and it is to these repeated lowerings of the nightly temperatures which in winter were of course much lower than in summer, that the rise in diapause has to be ascribed. Also the routine handling of the breeding jars beyond the thermostat creates similar conditions. Until careful breedings in thermostat rooms are performed we are unable to aknowledge these results. The matter is important enough to ask for the repetition of these and similar experiments under conditions avoiding faulty technique. In the following discussion we restrict ourselves to obligatory diapause which is entering into diapause at a certain stage of development independent or apparently independent of environic conditions.

This predisposition shows a great variability in most studied populations. Interesting is the case of *Bombyx mori* in Madagascar. PRUDHOMME (1906) states, about the univoltine race Bione,- and these statements are essentially correct for seven other univoltine races imported with it in September 1901 from France,- that the first larvae hatched at the same season in which they would have hatched in France. Yet from the second generation onwards it has given such irregular hatchings that at the beginning it was quite impossible to start normal breedings on an economic base. By rigid selection of the early emergent individuals of each generation it was changed within 18 months into a purely homodynamic population with five annual generations FOA (1927) comments quite correctly, that if rigid selection would have been made in the direction of univoltinism, a strictly univoltine strain would have been established just as easily. LAFONT (1911/18) notes that in Bengal a race with eight annual generations be established. At Midnapur uni- and bi-voltines are bred side by side with this homodynamic breed. Certain univoltine races remained in 1856 all univoltine in the following generation, with the exception of 0.2%. These 0.2% all died in the larval stage. In Indochina apparently no homodynamic breed has been produced. We may conclude, that the origin of the emergent homodynamic breed of Bengal was similar to that of Madagascar, by human selection from an unstable introduced race of unknown voltinism. The Mediterranean univoltine races of *Bombyx* show little tendency to accidental bivoltinism, whilst in races introduced from China or Japan a higher tendency in this direction is noted, and the strength of this tendency is a race character. The stability of voltinism in the Mediterranean area is the result of strict and prolonged human selection, as uniformity of hatching is an important factor in any economic calculation

of silkworm-breeding. If after centuries of rigid selection the tendency to change voltinism is still so strong, that it was possible to change univoltine races within 18 months into purely homodynamic breeds by rigid selection in the opposite direction, this shows – even taking into consideration, that many breeds which were not subjected to rigid negative selection did not show such a plasticity –, how great the individual range with regard to diapause is.

A physiological analysis of this variability has been performed by HELLER. In the region of Lwow the pupae of *Deilephila euphorbiae* usually go into diapause. But a small group remains in diapause for two years, whilst others may in a warm autumn yield moths a few weeks after pupation. HELLER could establish on physiological properties eight different groups: Four (no. 1, 2, 4, 5) are certainly based on constitutional differences, two (no. 3, 6) may be extreme cases of no. 2 and 5 only. For no. 7 and 8 either lethal hereditary characters or accidental diseases may have been the cause for their occasional appearance.

Types of pupal development of Deilephila euphorbiae at 22°C.

Type Description	Days development	Loss of weight	Lowest O_2 consumption per ccm.	Highest PO_4% per mg.	Glucose in haemolymph mg%.
1 biannual	640	very slow	-	70	-
2 dormant	270-330	slow	20	50	50
3 lethal dormant	die in winter	quick	20	-	-
4 protracted	40-50	fairly quick	35	-	-
5 emergent	17-21	quick	56	-	50
6 rapid	13	very quick	-	30	-
7 lethal soft winged	pupae die	-	-	-	220
8 lethal black pupae	pupae die	-	160	-	380

Groups 2 and 5 dominate, which results in a bimodal curve for that population. More than one character is concerned in the termination of the pupal diapause, as is evident from the analysis of the metabolism. The other six groups are rare.

M.L.PREBBLE (1941) in his masterly ecological analysis of *Gilpinia polytoma* in Canada found in various populations and strains a most varied behaviour towards diapause, when he bred selected lines in the incubator. He thinks that genetical factors control these variation, but confesses ignorance about their modus operandi. Further, the occurrence of emergent and diapause lines in both, in the one and two generation areas, though in different proportions, indicates that climate has only a partially selective action in

fashioning the composition of the population, from the various elements within the species. However it seems significant, that no strongly emergent lines have been found in the one generation area of Gespe, but only some lines that were partially emergent for a very few generations, but which terminated all in diapause. From the rearing of emergent lines transformed to Gespe it is clear, that there would be a partial survival of such stock in a one-generation area by virtue of diapause induced by environic causes.

Of fundamental importance are the studies of R.GOLDSCHMIDT (1933) on the diapause of the egg-larvae of *Lymantria dispar*, to which we will have to return in a later chapter. A certain temperature sum is needed for the hatching under favourable conditions which differs for every race. This temperature sum is however not the only factor involved. (Chilling of the eggs, as occurs in nature in winter, is not indispensable, but favourable.) Optimal is just that sequence of temperature and humidity which occurs in the natural area. In all other conditions a smaller percentage of larvae of each race hatch and the temperature sum required for hatching is higher than normal. The latter the eggs are transferred to temperatures favourable for development, from early winter to the normal hatching date in spring, the higher is the percentage of hatching larvae. This time element is still more important in the temperature-independent factor readiness to hatch'. If eggs which until January were kept under normal conditions and then removed on the first of the following four months to 11.5^{0}, hatching follows, with a great variation for the different races, as follows:

Transported on 1st of	Days to larval hatching
January	57-76
February	38-52
March	33-46
April	29-33

Readiness is thus highest at the normal hatching time. The results can be expressed by the following formula:

$$(T - \frac{c}{r})\, k \, . \, t = \text{constant.}$$

(T: environic temperature; c: threshold of development; r: readiness to hatch; k: a racial constant; t: time to hatching.)

GOLDSCHMIDT concludes that a number of genetic factors, most of them racially different, are involved in the diapause of *Lymantria*. The genetical analysis by cross-breedings reveals that in this species the longer incubation time is dominant. Matrocliny frequently appears in reciprocal F_1 and F_2 generations, which points to cytoplasmic influence. Yet conditions of maternal nutrition may also lead to such results. The distribution in F_2 is typical for the segregation of multiple factors. The similarity and the shape of the distribution curves in different crosses point to a segregation of few genes

only, possibly even one only with multiple allelomorphs combined with some modifiers.

We conclude these analyses of diapause genetics with a short discussion of the seasonal dimorphism of *Araschnia levana.* In nature the *prorsa*-form hatches from emergent summer pupae, the levana-form from hibernated diapause pupae. It was assumed, that high temperatures determine emergent development and *prorsa* formation, lower temperatures respectively progressive lower night minima diapause and *levana* formation. Yet SUFFERT (1924) in a competent analysis states that the experimental cold *levana*, exposed in the early pupa, is different from the normal *levana* from diapause pupae, and that by heat exposure of diapause pupae no *prorsa*-forms have ever been obtained. In general a great variation with many transitions between both forms indicates, that the diapause forms are only the extreme end of a great many forms, which appear under conditions of strict continued hibernation. This variability of individuals of the same group indicates in his opinion a great range in respect to the genetical diapause constitution.

In the discussion on the genetical background of diapause two opposite camps have been maintained one-sided theses. The genetical background is often accepted and mixed populations are regarded as mutations or the result of gene-segregations. This often uncritical attitude has led some students, such as SIMMONDS(1948) to doubt, if any genetical background exists at all, and if even in univoltine diapause the decisive environic factors have merely not yet been determined. Both these extreme attitudes seem unsatisfactory for a general explanation of diapause. We must remember the word of the statistician WEINSTEIN, who said: To ask if heredity or environment are more important for the organism, is to ask, if for the determination of a point in a system of coordinates the ordinate or the abscisse be more important. It seems that the problem cannot be precised in a better way. Our conclusion in a general way would be: To react towards disturbences of the normal coordination of the various independent or interdependent physiological chains of development by some kind of arrested development, permitting a rearrangement of the mutual relations of these processes seems to be a general property of organised nature, which in many cases is a favourable alternative to death by incompetence. This elementary tendency shows from species to species, from race to race, and to an often surprising degree within every race and population an enormous range of variation. This variation is the material from which selection and other factors model strains of different constitutions, of different sensitivity towards exterostimulations. Thus diapause, as a rule, is not a definite diapause gen, but the result of a number of gens which influence the relative speed and environic sensitivity of the various physiological chains of development, thus influencing their mutual coordination and thereby creating the constitutional or genetical background of diapause. Exterostimulations induce on this constitutional background differential preparatory reactions of the organism and its cells which are more or less favourable to the appearance of diapause. We have, so far, not

one indication of the occurrence of special diapause genes, but we have ample illustrations for a great constitutional variation in the physiology of insect development which undoubtedely is a genetical problem.

7. *The evolutionary aspects of diapause*

The discussion of the genetical aspects of diapause leads us straight to its evolutionary aspects. SIMMONDS (1948) has recently stressed, that sensitivity to enter diapause occurs – at least very often in homodynamic insects – in those individuals or groups which show a definite lowered environic resistence. He assumes that the more sensitive individuals are those in which earlier severe physiological disturbances appear, such as provoke diapause. And CHOPARD (1938) has shown that, to the contrary, also suppression of diapause weakens the vitality of insects, such as *Gryllus campestris.* It is too early to generalise; (but) SIMMONDS thesis is in many cases in full agreement with the observed facts. Yet he has closed his eyes to the reserve of the same phenomenon, namely that once diapause has set in, it has a protective effect and rises considerably the resistence in unfavourable environic conditions. This does not mean that diapause be exempted from mortality. When conditions grow very unfavourable and last for a protracted period, also diapause mortality is high, as we have seen in the cocoon-larvae of *Carpocapsa* at Baghdad or in the eggs of *Dociostaurus,* when no contact humidity is available one year after oviposition. Anyhow, wether the lowered vitality of the prediapause stages in individuals entering diapause is a general phenomenon or not, it clearly has in either case a high survival value.

This survival value is much enhanced by another phenomenon: Experience repeated over and over again shows that diapause aids to fit the active and most sensitive stages of an insect into that part of the annual cycle, where climate and vegetation are most suitable. Already KIRBY and SPENCE (1818) have pointed out, that the end of hibernation in most species coincides with the sprouting of the host plant, and in some aphids this hatching differs as much as one month and more, according to the sprouting of their various hosts. How complicated this process of adaptation is, has been demonstrated by the pioneer work of GOLDSCHMIDT on *Lymantria.* Considering the high variability with regard to diapause which we find in most insect populations, it is obvious, that fixed diapause behaviour in a severe environment is the outcome of prolonged rigid natural selection. If the caterpillars of *Lymantria dispar* would hatch much earlier or much later, they would have to wait too long for the appearance of the soft oak leaves or these would already be too hard to serve as suitable food for the neonates. The most complicated adaptation establishing the co-presence of both, larval hatching and sprouting of the host in every geographical area, has an enormous survival value. The same observation can be repeated again and again: The larval offspring of the emergent *Deilephila* pupae in a warm autumn near Lwow dies early in winter for want of food and for not being prepared to enter into diapause.

This survival value is still much stressed by other observations. Inspite of favourable periods of autumn weather most insects in arrested development or activity remain in this condition until the following spring. We have shown for the summer-winter aggregations of *Coccinella septempunctata* on the peak of the Elma Dagh near Ankara, that 1) in autumn not sufficient aphids for massive development of a new generation of lady beetles are present, 2) the period of favourable weather in autumn is too short to permit development to the beetles, and the earlier stages, not fit to enter diapause, would be all killed in the severe winter exposure. Or, in Israel, neither the maggots of *Eurytoma amygdali*, nor the cocoon-larvae of *Cimbex humeralis* break their diapause during the favourable weather conditions of autumn. The former, if awakening then, would find no soft almonds for oviposition, the later no soft almond leaves for oviposition and for larval food.

As there is not the slightest chance, that the insects concerned know about these dangers, there is no other solution than to assume that a most rigid natural selection working for many milennia on the plastic diapause constitutions in a fixed cycle of climate and environment of a given locality has weeded out those strains and individuals which did not fit into this rythm of local conditions. This does not mean that by recurrent mutations, e.g., and other mechanisms the population cannot anymore change. Transported into another region, the same population, if it can survive in whatever small percentage the initial dangers of the transfer, would doubtless again establish a well adapted diapause behaviour, especially if the new environment be more lenient than that of the former habitat.

PICTET (1915) has given a good illustration of the survival value of the seasonal fitting produced by diapause in his breedings of *Lasiocampa quercus*. An interesting point is that the Swiss race has a pupal, the Sicilian one an egg-diapause. This demonstrates the ability of a species to manifest in different regions diapause in two different stages of development. Important for our discussion is, that all those breedings in which by artificial stimulation eggs were laid to abnormal seasons, the offspring died prematurely before reaching the age of reproduction.

In insects occupying a vaste territory, where in one part one, in others two or more annual generations of the same species occur, we usually find, especially if the date of settlement of the insect is more or less recent, two or more strains coexistent, conspicuously so in the transition zone from the one to the two generation area, whilst within the one or two generation area the non-agreeing strains are less abundant. It has been established in U.S.A. that latent and emergent strains of the recently introduced *Pyrausta nubilalis* coexist in both areas. Yet in most long-established two or more generation areas of other insects it is found, that whilst emergent strains crop out – often not manifesting themselves as such, as in normal years the usual exterostimulations lead them to diapause in the one generation area –, latent stock is rare in the more generation areas.

PREBBLE (1941) who studied these conditions for *Gilpinia proxima* in

Canada came to the following conclusion: The copresence of emergent and latent lines in both, one and two generation areas, though in different proportions, indicates that climate has in this case only a partially selective action. It is however significant, that no strongly emergent lines have been found in one generation area of Gespe; at most only lines that were partially emergent for some generations, then terminating altogether in diapause. From the rearing of emergent lines transferred to the Gespe area it is clear, that there would be a partial survival of such stock in a one generation area by virtue of diapause induced by environment. At the other extreme, diapause lines would appear to have no intrinsic handicap in an area favourable to the development of two and more annual generations; but in view of their slower rate of increase they would in time be greatly outnumbered by emergent strains that made full use of the environic possibilities. This is, of course correct. In addition however the different vitality of the various strains in the various environments has to be considered. The environic causes that induce diapause in emergent stock with advance of the season are obscure, but the adaptive value of the phenomenon is apparent in view of the fact that development is arrested in cocoons of emergent stock spun in late August under temperature and moisture conditions in the soil about as favourable as those of May/June, when development is resumed.

We come to the following conclusions: Diapause has a great survival value by rise of resistence to unfavourable environment and by fitting many insects into the local environic rythm. These highly competent and significant adaptations are the outcome of a more or less rigid natural selection upon a broad range of variation with regard to diapause inclination within insect populations, at least those which are not subjected to an extremely rigid selection for millennia. This adaptive survival value makes diapause a paramount factor in the maintenance of the species in its struggle of existence and in its evolution within an environment not continuously favourable for its maintenance.

8. *Theories of diapause*

The earliest modern explanation of insect hibernation was the theory of the Physico-Theologians since about 1750, who regarded it as a conspicuous sign of the providence of God. The earliest attempt of a scientific interpretation is probably the assumption of the genial French physiologist Claude BERNARD regarding the hibernation of mammals, that it be based upon a general organismic sensitivity, and especially of the nervous system, towards cold. Whilst untenable in its original form, BERNARD's general conception that reactions towards unfavourable exterostimulations, such as cold, often inducing inactivity or arrested development, are a general property of organisms is still the most general statement which can be made about diapause.

The theory that diapause be a process of selfpuration from metabolic intoxications was first presented by K.SAJO (1896). BAUMBERGER (1914)

states, that in *Carpocapsa pomonella* following a period of overfeeding inactive metabolic products are stored in the cytoplasma which diminuish the cell permeability. This intoxication leads to a precocious senescence of the tissues accompanied by a lowered speed of the metabolis processes. This be the cause of hibernation- The low winter temperatures favour the precipitation of these inclusions and lead to a kind of rejuvenation of the organism.

E. ROUBAUD became a most energetic promotor of this theory. He identified the toxic substances with urates and assumed, that the toxic urates be not only accumulated during individual life, but also be eventually transmitted to the off-spring. In this way he tried to explain those cases, where a diapause generation appears alternating with one or some emergent generations. A good number of physiological analyses, the last by WIESMANN, failed to substantiate this theory, as no accumulation of urates could be found. The same is true for other toxic substances. FOA, e.g., fed silkworms with the leaves of *Maclura,* which contain certain toxic substances, and failed to find any diapause induction.

GOLDSCHMIDT (1933) came by his analysis of the diapause of *Lymantria dispar* to the conclusion, that the differences in the racial diapause manifestations be based upon the production of an inhibitor substance in different quantities or at varying rates. Once this substance reaches a sufficient concentration, a diapause supervenes. In some races this inhibiting substance appears in every generation, in others in any following one.

A similar conception has been developed by BODINE (1932) and by most other students who studied the diapause of grasshopper eggs. A growth inhibiting 'diapause or X factor' increases in amount, but is gradually destroyed or itself inhibited by exposure to low temperatures, thus giving way to the continuation of development. BODINE produces evidence for considering the action of the diapause factors as of an 'all or none' type of reaction.

WIGGLESWORTH (1931) ascribes diapause to the temporary absence of factors or hormones required for the maintenance of growth. In *Rhodnius* the moulting hormone is secreted only after a full meal of blood. When the bug receives too small meals or if the head is removed soon after a large meal, before the responsible endocrine glands shed their secretions into the haemolymph, growth is arrested. WIGGLESWORTH suggests, that possibly a diapause factor be secreted from the brain.

Additional theories increase the number of factors involved to two or three substances, which partly are antagonistic to one another. All these theories belong to one group, provided that we conceive the inhibitor substances as poisons.

The most elaborate study so far produced on our problem is the Etude experimentale de la Diapause des Insects (1932) of Mlle G. COUSIN, a broad and deep analysis of diapause phenomena in *Lucilia sericata* and related flies. She studied the effect of the environic factors inducing diapause, the

possible influence of genetical factors, the influence of metabolic rate on diapause. After a discussion of temperature, humidity, food, hydration, bound water, respiratory rate, physical state of protoplasm, etc. she concludes that any unfavourable condition of any of a number of factors will increase the tendency towards diapause. COUSIN claims that there exist as many different diapauses as there are different factors which may induce it, and that every type of diapause can only be broken by the influence of those factors which induced the special diapause concerned. This is e.g., in direct contrast to the work of DUCLAUX (1876). Unfavourable exterostimulations may induce diapause either immediately or at a later stage of development, eventually even in the offspring. This elaborate study was intended as a critical study of ROUBAUD's theories, whose experiments were based mainly on the same species and other Diptera. Her criticisms regarding the intoxication theory of ROUBAUD are well conceived, yet her generalisations as well as those of ROUBAUD suffer from one serious drawback: They both studied only homodynamic species with facultative diapause, and not even one heterodynamic form with one annual generation and obligatory diapause. The strong negation of genetical diapause factors by Mlle COUSIN is today generally accepted for homodynamic insects, whilst the position for heterodynamic species has been discussed before. COUSIN's book remains a marking stone in the development of diapause theories. She represents the school of thought which denies the need to assume any inhibitor substances, or an accumulative auto-intoxication in the sequence of generations.

The negation of inhibitors responsible for diapause is shared by many recent students. Already the hormonal conceptions of WIGGLESWORTH (1931) do not necessarily implicate their participation and C.M. WILLIAMS (1948) denies in his analyses of hormonal effects expressedly the need to involve any inhibitors into the diapause mechanism. F.J.SIMMONDS (1948) most energetically promotes the conception, that there exists one type of diapause only induced by abnormalities in physiological processes and hence in the metabolic rate. This principle may explain diapause without ressort to conceptions of excretory intoxication, hormone deficiences, growth inhibitors, etc.

It has been pointed out before, that all those physiological theories which claim that the effects of dehydration, of different food composition, of activation or inactivation of enzymes or hormones be the responsible diapause mechanism, cannot be accepted; but that every one of them describes an important part of the many physiological and metabolic changes which occur in the organism concomitant with the preparation, setting in, maintenance and breaking of diapause.

We wish to mention here only one further theory. Miss E.SLIFER (1945) discovered that the hydropore, the water imbibing area of grasshopper eggs, be closed, apparently by a thin wax layer which may reduce oxydation as well as prevent water absorption, and that diapause is broken, after the wax layer disappears and the hydropore becomes fit to imbibe water. This is

rather a special case and, until experiments teach us differently, we prefer to assume, that these important changes also accompany diapause more than that they represent its primum movens.

To return to the problem, if there exists one (SIMMONDS) or more (COUSIN) types of diapause. We all agree, that diapause is the organismic reaction towards unfavourable exterostimulations, producing and manifesting disturbances of the normal cooperation of various metabolic chain-processes. Yet this assumption does not involve, that all these diapause reactions be physiologically identical. On the other hand, it is obvious that where heavy dehydration precedes diapause, imbibition of contact water is at least one of the factors needed for its breaking. Many primitive changes with regard to the viscosity, permeability, reactivity, etc. of the cell are induced automatically by mere dehydration. The same is true for temperature and other factors. Yet once favourable environic conditions are restituted, many factors and shocks may vicaryingly effect the breaking of the diapause. But the fact, that many factors may vicaryingly substitute one the other in breaking diapause is no decisive proof for the unity of diapause as one unique physiological condition. To the contrary: As the factors inducing diapause, the stage in which it is induced and manifested, etc. are very different, it would be more than surprising if really there would exist one type of diapause only. The analogy of certain basic symptoms, such as dehydration, fat storage, depression in metabolic and enzymatic activity, etc., is insufficient to ascertain one unique type of diapause. SIMMONDS himself has to agree, that diapause is not a strictly definable state, but merges on the one hand into easily reversible temporary arrests of development caused by immediate environic influences, and on the other hand to cases where severe physiological disturbances bring about high mortality and deformity of the emerging adults. Also, it is clear that some cases of diapause may possibly be caused by abnormalities of physiology: accumulation of excretory products, hormone deficiencies, or definite genetical influences. It thus seems, that the antithesis of one or more diapause types is more a struggle of words than of basic conceptions.

9. *Outlook*

Apart of the cases of insect diapause discussed so far, we have to take into consideration, but can mention them here only because of lack of time, certain special and related cases. Thus in the castes of social Hymenoptera the disturbed coordination of the normal female gonade development is not taken up where inhibition did set in, but is continued into different directions, producing quasi a permanent imaginal diapause (reinterpreation of HAYDECK). Disturbances in the development of many holometabolic insects lead to pro- or metatelic teratological transformations (SINGH PRUTHI). The influence of adverse factors on the establishment of alates, of special morphological hibernants or of the sexupara in aphids is well known (HILLE RIS LAMBERS). These and many other phenomena must also be considered, as

also induced by physiological disturbances following unfavourable extero-stimulations, before a full understanding of the diapause phenomena is feasable.

We have let pass before our eyes the great advances of the diapause problem within the last 50 years, which are marked by names like WHEELER, TOWER, ROUBAUD, PICTET, COUSIN, HELLER, BODINE, SLIFER, GOLDSCHMIDT, WIGLLESWORTH, PREBBLE, JOLY, WILLIAMS, SIMMONDS and DICKSON, to mention only the outstanding mark stones of this advance.

Diapause is a widely spread primary reaction of the organism against unfavourable environment. This is correct also for genetically fixed diapause, which is the outcome of long and rigid natural selection upon a broad range of individual variation in diapause behaviour. Dehydration, fat storage, changes in activity of enzymes, hormones, respiration, etc. are only concomitant symptoms of diapause, but neither any single one of these factors nor all together can be considered as the primum movens of the diapause mechanisms. Every one of these factors is part of the many interdependent changes which occur *previous* to diapause and during it. It is far from proven, that these physiological secondary changes are the full description of diapause.

This leaves us today, apart of simplicistic inhibitor effects, with two basic conceptions of the physiological mechanism of diapause:

The one school, promoted by SIMMONDS, regards diapause as the breakdown of the normal time-space coordination of development. This breakdown leads to a disruption of normal development, until through some still obscure physiological processes recovery has taken place enabling continuation of development. In a certain sense this is an organismic application of LIEBIG's law of minimum.

The other school is that of incretory regulation. The preparatory changes to dormancy, such as increase in fat, dehydration, changes in the size and activity of gonades, even reversal of taxic responses, etc. should have suggested long ago, that insect diapause is regulated by changes in the incretory glands similar to those which govern hibernation and rutting season in mammals. The want of actual information on incretory mechanisms in insects prevented such assumptions until recently. Yet the last decade has informed us about a growing number of such mechanisms. Especially the beautiful work of JOLY and WILLIAMS has contributed much to strengthen this view. We can visualise today quite easily, even if many points still remain obscure, that diapause is induced by exterostimulations, which change the activity of various incretory glands, and which switch thereby over the normal metabolism into another phase of different intensity and quality. The already recognised complexity of this incretory mechanism explains the manifoldness of the phaenomanifestations of diapause, which is still more complicated by genotypical fixation in a number of cases, which show all kinds of transitions from rigid hereditary fixation to facultative diapause in an unfavourable environment. This conception combines an explanation bas-

ed upon unity of the basic phenomena with a multitude of variations in their manifestation. The main factor preventing its general acceptance is a still prevailing prejudice, that insects are less regulated by hormones than mammals or birds. Yet the rapidly increasing observations to the contrary makes this later explanation more and more probable. It should however not be forgotten, that in insects as well as in vertebrates the seasonal changes in the activity and structure of the incretory glands are reactions of highly sensitive organs upon exterostimulations, well illustrating the active interplay between organism and environment.

LA POSITION DE LA RECHERCHE BIOLOGIQUE EN ENTOMOLOGIE APPLIQUEE

Historique - Développement - Perspectives

par

Robert REGNIER et Bernard TROUVELOT
France

Introduction

L'étude des rapports entre l'Insecte et l'Homme, dont s'occupe l'Entomologie appliquée prend dans nos préoccupations une importance grandissante que reflètent les réunions internationales. En mettant à l'ordre du jour la position de la recherche biologique et en nous demandant d'en analyser rapidement les résultats et d'en montrer les perspectives, les organisateurs de ce Congrès ont prouvé leur souci d'information et d'objectivité, mais ils nous ont mis également devant une tâche difficile du fait de la complexité même de la question.

C'est qu'en effet le développement de l'Entomologie appliquée est lié non plus seulement à celui de la Biologie mais également à deux autres sciences, la Physiologie et la Toxicologie dont les activités conjuguées doivent permettre de résoudre les problèmes posés par la pullulation des espèces nuisibles.

La Biologie a pour rôle essentiel de préciser les moeurs des insectes, les conditions de nuisibilité, les époques et les points de vulnérabilité, et s'oriente de plus en plus vers les recherches écologiques et phénologiques, tandis que la Physiologie nous renseigne sur le métabolisme, les conditions du comportement, de la croissance de l'insecte et de la prolifération des espèces, et que la Toxicologie détermine la sensibilité de celles-ci aux poisons dont l'homme peut disposer pour se protéger ou protéger de qui l'intéresse. Cette étude rentre maintenant dans les attributions d'une autre science, la Phytopharmacie qui a pour objet: „l'étude des produits et préparations destinées à la protection et à l'amélioration de la Production végétale, à l'exclusion des engrais", ainsi que l'a défini récemment le Comité permanent international, science dont l'épanouissement correspond aux besoins de l'économie agricole moderne.

Si historiquement les recherches biologiques ont eu une action prépondérante, celles de Physiologie et de Toxicologie prennent à leur tour une grande importance sur le plan pratique c'est à elles trois, il ne faut pas l'oublier, à leurs apports sans cesse renouvelés que l'on doit les progrès réguliers et marquants de l'Entomologie appliquée. Devant l'évolution du comportement humain due aux moyens sans cesse accrus d'interpénétration des peuples, l'Entomologie ne saurait demeurer statique; le développement de la productivité est intimement lié à celui de nos connaissances, qui, chaque jour doivent être plus précises, pour que les solutions provisoires

apportées aux problèmes de lutte contre les insectes nuisibles s'adaptent plus étroitement aux exigences économiques.

Historique

Il n'est pas dans mes intentions de refaire ici l'histoire de l'Entomologie biologique, Qu'il nous suffise de rappeler les travaux que l'on doit dès le XVIIe siècle à deux naturalistes hollandais, l'un peintre, J.GOEDART, l'autre théologien, MEY, qui publièrent en 1662 (en latin) leur ouvrage sur les métamorphoses et l'histoire naturelle des insectes; les découvertes de l'illustre savant hollandais SWAMMERDAM sur les métamorphoses et les études sur la nymphose (1669), le traité du Ver à Soie du savant bolonais Marcello MALPIGHI (1669).

Au XVIIIe s. bien que le terme d'Entomologie appliquée ne figure pas encore dans les textes, nous voyons se développer toute une série de recherches, qui devaient en consolider les bases. Les travaux de A.VALLISNIERI, medecin de Padoue, disciple de Francesco REDI, sur le développement d'insectes utiles comme le Fourmilion et l'Ichneumon, ou nuisibles comme le Kermès, les Charançons ou les Vers des fruits (1713) ceux du Suisse BONNET sur la parthénogénèse des Pucerons et la respiration des chenilles, et de ROESEL VON ROSENHOF sur les métamorphoses, en font foi.

Dans ce domaine les Mémoires du Français REAUMUR, parus de 1734 à 1742, le Traité d'Insectologie de Charles BONNET, publié de 1748 à 1779, les Mémoires du Suédois Charles DE GEER, contemporain de LINNÉ, parus de 1752 à 1778 apportent une foule de renseignements et feront pendant longtemps autorité.

Nous n'aurions garde d'oublier la remarquable étude de Pierre LYONNET, de Maastricht sur la chenille de Cossus.

On peut dire que dès le début du XIXe siècle la voie est ouverte, nous voyons alors apparaître à côté des systématiciens toute une pléiade d'entomologistes qui se livrent, les uns à l'étude de l'anatomie, de l'histologie et de la physiologie des insectes, comme DE SAVIGNY, HEROLD, NEWPORT, Léon DUFOUR, TREVIRANUS, AUDOUIN, E.BLANCHARD, MECKEL, LEUCKART, les autres à l'étude de leur développement et de leurs moeurs, comme François et Jean-Pierre HUBER, qui étudient abeilles et fourmis, SIEBOLD et DZIERZON - qui étudient la parthénogénèse - STRAUS-DURCKHEIM et HEER qui étudient le Hanneton et RATZEBURG le père de l'Entomologie forestière.

Dans la seconde moitié du XIXe siècle, l'essor de l'Entomologie devient mondial. On a compris partout l'importance que peut avoir la connaissance de la biologie des insectes pour la production agricole ou forestière, et la conservation des denrées. On commence à voir paraître des ouvrages en-

tièrement consacrés aux problèmes d'Entomologie agricole comme ceux de GOUREAU (1861) de M.GIRARD (1872) de J.H.KALTENBACH (1874) et même à des cultures particulières comme celui de VALERY-MAILLET (1883) sur la vigne.

Les méthodes d'investigation se complètent et se diversifient. On s'attache à préciser le cycle évolutif des espèces ayant une importance économique, le nombre de leurs générations leur fécondité, leurs déplacements, leurs migrations, les végétaux qu'ils attaquent.

L'établissement de ce premier inventaire fait apparaître le rôle des entomophages dans la limitation naturelle des pullulations. Il n'y a qu'un pas à franchir pour penser à l'utilisation qu'on pourrait en faire en les important dans les régions ou des ravageurs ont été introduits sans leurs ennemis naturels habituels. Prédateurs et parasites font l'objet d'études attentives. La notion d'équilibre faunique et la nécessité de son maintien ou de son rétablissement en cas de rupture apparaissent à quelques esprits avertis. La recherche entomologique entre dans une phase nouvelle, qu'illustreront des savants comme RILEY, HOWARD, BERLESE, ESCHERICH, SILVESTRI et notre éminent maître Paul MARCHAL, promoteurs des grands travaux sur les entomophages.

C'est incontestablement parce qu'ils furent de grands biologistes que l'Entomologie appliquée leur doit d'avoir pu prendre la place qu'elle occupe aujourd'hui.

Les recherches ne vont d'ailleurs pas se limiter aux entomophages: des travaux comme celui de PASTEUR sur les maladies du Ver à Soie (1870) et ceux de A.GIARD sur les entomophytes montraient l'utilité des études sur les microorganismes non seulement pour la lutte contre certaines maladies des insectes utiles, tels que le Ver à Soie et les Abeilles, mais également le parti qu'on pourrait éventuellement en tirer contre les insectes nuisibles.

De même les importantes recherches de la fin du XIXe siècle sur le rôle des insectes dans la transmission des maladies à l'homme allaient tout naturellement amener à penser qu'il pouvait en être de même de la transmission de maladies aux plantes; les études sur les viroses en sont la preuve.

Développement

Si dans les soixante dernières années, l'évolution de l'Entomologie appliquée fut rapide, c'est, il faut le reconnaître, qu'elle répondait aux nécessités de l'heure. Autrefois les naturalistes avaient avant tout un souci d'inventaire, d'analyse, puis vint la notion de synthèse, dont la Biologie est l'expression. Les techniciens, pour sortir de l'empirisme, doivent faire appel aux biologistes; il en résulte une interpénétration de la science et de la technique qui, au cours des trente dernières années finiront par faire cause commune.

En raison des bouleversements que ces tendances apportent, il n'est pas étonnant de retrouver à l'origine les réserves et les oppositions qui ont

présidé à l'épanouissement de toute science nouvelle. L'époque n'est pas lointaine où l'étude de la biologie des insectes agricoles était considérée comme une science de seconde zone, et l'on peut dire que pendant longtemps la recherche scientifique a souffert de cette séparation des tâches et de la conception platonicienne de la division en science pure et en science appliquée. Il a fallu toute l'autorité des savants que nous avons cités pour imposer la doctrine nouvelle, réclamée par le développement de l'agriculture, auquel elle est directement profitable.

La pénétration coloniale pose de son côté des problèmes humains, que seules des études de cet ordre peuvent résoudre, qu'il s'agisse de la lutte contre les parasites de tous genres ou de la mise en valeur du sol.

Etudes écologiques

Les études biologiques devaient entrer dans une nouvelle phase importante, dès que l'on comprit qu'il n'était pas possible de résoudre les problèmes posés par la pullulation des insectes, et les conditions dans lesquelles ils vivaient. (Habitat, ambiance). Ainsi naissait cette grande subdivision de la Biologie: l'Ecologie dont les études sont si poussées depuis une vingtaine d'années. La notion d'Ecologie ouvrit les portes sur un véritable monde pour les recherches, avec des horizons nouveaux et des perspectives inattendues; le stade des études des insectes en laboratoire, sur un nombre restreint d'individus, dans une ambiance artificielle, était dépassé. Il apparaissait nécessaire désormais de considérer les groupements, les peuplements, les biocénoses, leur interdépendance. Au travail de laboratoire se trouvait non pas substitué, mais ajouté le travail dans la nature, qui devait révéler des faits d'une importance fondamentale pour l'application plus rationnelle des méthodes de lutte. En même temps, elle amenait à poser aux physiologistes une foule de questions dont l'étude s'avéra des plus heureuses: les recherches sur le grégarisme et le phénomène des phases chez les Criquets, sur les diapauses, les tropismes, les tactismes et la possibilité de leur renversement, soulignent la diversité et l'étendue du champ offert aux investigateurs.

Etudes des populations

Les études écologiques sont à peine entamées que déjà une autre notion s'impose à l'esprit des biologistes, celle des peuplements, des populations d'Insectes. L'importance des dégâts est en effet, pour une large part en fonction des densités locales: il y a pour les différentes espèces un seuil de nuisibilité, qui varie d'un végétal à l'autre. Telle culture supportera sur son système radiculaire une densité de 20 larves de Hanneton commun, (*Melolontha melolontha L.*) au mètre carré, tandis que telle autre n'en supportera que le dixième, et encore ce seuil pourra-t-il être notablement abaissé, si le sol est très sec. Partant de cette notion, c'est par le dénombrement des „survivants" après un traitement que l'on peut apprécier la valeur agricole d'une technique de lutte.

L'étude des populations conduit également à des investigations sur leur comportement, leurs déplacements, les conditions de leur persistance, et de celle de leurs parasites. C'est grâce à la connaissance de ce mécanisme complexe que deviennent possibles les présomptions de pullulations. La lutte contre un ravageur pose une foule de problèmes techniques et financiers, qu'il n'est pas toujours possible de résoudre à l'apparition de celui-ci. Pour la préparation des Opérations-Hannetons, la pratique des sondages à l'automne précédant les sorties de printemps nous a fourni des renseignements assez précis pour permettre de les préparer dans une région déterminée, et d'en chiffrer à l'avance les dépenses. Ce n'est là qu'un exemple, dont nous avons apprécié la valeur et qui prouve que les succès pratiques impliquent des études écologiques poussées précédant la mise en place des applications.

Les relevés effectués permettent de définir les „états d'infestation" et de préciser les zones et les emplacements sur lesquels les interventions antiparasitaires sont payantes, l'irrégularité des infestations sur un même territoire risquant de nuire à la rentabilité des opérations.

Etudes fauniques

Mais d'autres tâches s'imposant aux biologistes qui s'occupent d'Entomologie appliquée: elles relèvent du secteur faunique. Non seulement les inventaires d'espèces nuisibles doivent être constamment révisés, mais d'autres aspects des problèmes doivent être envisagés: tels que la présence possible de véritables races biologiques chez les phytophages, de plantes-hôtes nettement préférentielles, de différences marquées dans les tropismes, la fécondité, le pullulement et le comportement vis-à-vis du végétal attaqué. Les révisions d'inventaires fauniques doivent nous permettre de rectifier notre opinion sur beaucoup d'espèces et d'éviter des interprétations hâtives, qui sont à la base d'insuccès dans la lutte.

C'est grâce aux études fauniques conduites sur le plan écologique que nous pouvons contrôler les possibilités de déplacements fortuits des phytophages d'une aire continentale vers une autre leur offrant des conditions favorables d'implantation. Les risques s'en trouvent journellement accrus par le développement de l'aviation.

Lutte biologique

Et puisque nous parlons d'Entomologie appliquée, essayons de faire très objectivement le point sur les perspectives actuelles de la lutte biologique, à la lumière de plusieurs décades d'expériences.

Celle-ci comporte plusieurs chapitres distincts: l'utilisation des prédateurs et des insectes parasites, des microorganismes, la sélection des plantes résistantes et l'emploi des phytophages pour la destruction des plantes envahissantes. Malgré de nombreux échecs dûs à une connaissance insuffisante des origines des espèces nuisibles ou au comportement des prédateurs, des parasites et des phytophages, on lui doit des succès retentis-

sants, notamment dans les territoires insulaires où les conditions d'ambiance sont moins variées et où la compétition est plus limitée. Il n'en est pas de même pour les régions continentales: les réussites d'acclimatation aussi complêtes que celle du prédateur *Rodolia* (*Novius*) *cardinalis* demeurent proportionnellement peu nombreuses.

Le succès est subordonné à un certain nombre de conditions qu'il appartient au biologiste de déterminer avant detenter l'introduction sur un autre territoire: c'est d'une part le pouvoir de reproduction, la mobilité et la voracité de l'entomophage, d'autre part ce sont les possibilités de persistance du ravageur. Le succès est en outre conditionné par la connaissance précise des exigences climatiques et écologiques de l'entomophage, l'analyse des fluctuations de population, la recherche des foyers de conservation, l'étude des processus de dispersion et d'infestation du ravageur. Problème vaste et complexe qui nécessite l'emploi d'équipes spécialisées et la coordination du travail par un chef d'orchestre averti et compétent.

Des exemples récents montrent en outre la possibilité d'utilisation d'espèces oligophages pour combattre un ravageur voisin de l'hôte primitif et l'intérêt de ne pas limiter les recherches aux entomophages essentiels.

Il est extrêmement difficile d'établir des règles, tant sont variés les aspects des questions à résoudre. L'acclimatation peut être rapide, dans le cas d'un prédateur, avec les parasites elle est au contraire toujours assez lente. C.P.CLAUSEN considère que les espèces intéressantes au point de vue économique doivent pouvoir s'établir dans leur nouvel habitat en 3 à 6 ans, si l'introduction des souches a présenté toutes les garanties désirables. Passé ce délai, les espèces n'ayant pu s'acclimater ont peu de chances de jouer un rôle actif et la poursuite du travail n'apparaît pas essentiel.

L'emploi de microorganismes (bactéries, champignons) est demeuré jusqu'ici d'une valeur incertaine. Il convient cependant de noter l'intérêt des résultats obtenus avec la „Milky disease" pour combattre *Popillia japonica* New. Nous pensons que la méthode ne peut avoir d'avenir que si les études d'épidémiologie sont développées pour déterminer la manière dont les germes se maintiennent, se propagent et contaminent les nouveaux hôtes dans les champs mêmes, les conditions artificielles d'élevage en laboratoire étant susceptibles de mettre les ravageurs dans un état de réceptivité et de sensibilité qui n'existe pas dans la nature.

L'étude des facteurs de résistance des végétaux aux attaques des insectes constitue un autre chapitre de la lutte biologique. La réussite déjà ancienne de la lutte assez empirique contre le Phylloxera de la vigne demeure un cas plutôt isolé, mais il est patent que lorsque l'on prend soin de noter les coefficients de pullulation, de vitesse de peuplement et d'intensité des dégâts sur les différents clones ou variétés d'un même végétal, on constate la diversité des liens de dépendance entre le ravageur et la plante et des modifications dans la pullulation de l'insecte qui peut suivant les cas

être accélérée, ralentie ou même stoppée par la nature du végétal.

De telles recherches sont longues et difficiles et de ce fait n'ont été jusqu'ici qu'ébauchées, mais il est incontestable qu'elles présentent un intérêt certain. Nous n'en voulons pour preuves que celles qui sont actuellement faites en Amérique du Nord, en Hollande, Allemagne et Italie. La sélection des clones italiens de Peupliers, pour n'en citer qu'un exemple, est maintenant étroitement subordonnée à l'étude de leur résistance aux insectes comme aux maladies. Il n'y a aucune raison pour que les succès obtenus à cet égard dans le domaine de la Pathologie végétale ne s'affirment pas aussi dans celui de l'Entomologie appliquée.

L'idée trop classique que la sélection affaiblit la résistance des végétaux, ne repose pas sur des bases assez sûres pour qu'on en fasse un postulat, et ne paraît se justifier que par l'imprécision de nos connaissances en matière de réceptivité, et notamment parce qu'on omet de déterminer le degré d'attaque des insectes dans les épreuves sélectives. L'important mouvement qui se dessine actuellement dans ce domaine, du côté de la recherche en matière de céréales, de maïs, de sorgho et de Pomme de terre, et de Populicultures, est appelé, nous en sommes convaincus à s'amplifier.

Dans les méthodes de lutte biologique, il convient de mentionner également les techniques assez récentes de limitation naturelle des plantes envahissantes et des mauvaises herbes par l'acclimatation d'insectes phytophages.

Elles ont déjà rendu de grands services dans divers pays de l'hémisphère sud, notamment en Australie et en Afrique du Sud. Elles nécessitent beaucoup de circonspection et des études très poussées pour éliminer les risques d'adaptation à un végétal utilitaire et sont d'un avenir certain pour les pays neufs en particulier.

Equilibres fauniques

La question des équilibres fauniques n'a jusqu'ici été qu'effleurée. Tout le monde en parle, mais nous devons avoir le courage de dire qu'en ce domaine nos informations sont très réduites. Etant donné ce que nous savons du rôle des auxiliaires dans la nature. il est tout naturel de penser qu'en généralisant l'emploi massif d'insecticides polyvalents, comme le sont notamment les nouveaux insecticides organiques de synthèse, on risque de les détruire en même temps que les ravageurs, mais, à notre avis, autant il est rationnel de condamner des applications inconsidérées, autant il apparaît contraire aux intérêts de l'agriculture de déconseiller de prime abord tout traitement important qui permet de lutter efficacement contre un ravageur, contre lequel on se trouvait désarmé jusqu'ici.

La lutte antiparasitaire présente tellement d'aspects qui varient avec les espèces incriminées qu'il apparaît inopportun d'avancer ici une opinion avant que des relevés expérimentaux, détaillés et répétés n'aient été effectués. C'est un travail que nous connaissons pour l'avoir pratique et qui est sub-

ordonné à des moyens puissants qui ne sont à la portée que d'équipes spécialisées. En matière économique, ce qui compte c'est le résultat. Il ne faut pas oublier que tous les jours l'homme rompt les équilibres biologiques, en mettant en culture des végétaux nouveaux, en défrichant les landes et les bois, en affectant à des cultures spéciales des espaces énormes, par conséquent en modifiant le milieu où les espèces animales et végétales étaient en compétition.

Il ne s'agit pas de savoir si le traitement qu'on effectue a détruit des auxiliaires, mais dans quelle proportion il les a détruits, et si, en fin de compte, celui-ci n'a pas été plus utile que ne l'aurait été l'intervention progressive des entomophages.

Un exemple frappant nous est offert par les pullulations d'Hyponomeutes sur les Pommiers en Normandie. On sait combien ces insectes sont sujets au parasitisme, mais on sait également que celui-ci exige généralement trois à quatre ans pour enrayer la multiplication du ravageur. Doit-on par conséquent laisser aux parasites le temps d'intervenir et risquer de perdre deux ou trois récoltes de fruits, alors qu'en traitant on peut juguler l'attaque dès la première année?

Ceci ne préjuge en rien des études qui sont à poursuivre. La lutte chimique donne des résultats immédiate et qui sont peut-être provisoires; la lutte biologique nous ouvre des perspectives complémentaires.

Perspectives

Le rôle du biologiste en Entomologie appliquée apparaît chaque jour plus important et la diversité des tâches qui lui incombent devient de plus en plus lourde; en raison des précisions qu'exige la solution des problèmes de lutte, la spécialisation s'impose; elle explique, comme nous l'avons dit plus haut, l'orientation des uns vers les études biologiques proprement dites, en particulier vers l'Ecologie et la Phénologie, des autres vers la Physiologie ou la Toxicologie, et la tendance marquée à l'individualisation de ces sciences. Celles-ci d'ailleurs fournissent des apports fondamentaux à la connaissance de la vie de l'insecte, de son pouvoir de reproduction et par contre-coup de son degré de nuisibilité. Les aptitudes et particularités précisées par les physiologistes (tropismes, diapause, fécondité en fonction de l'alimentation etc. . .) intéressent directement le biologiste et l'écologiste et leur permettent de définir les caractères des déplacements, des envahissements, des pullulations et parfois de la grégarisation, de la résistance des insectes aux traitements apparemment les plus efficaces.

Dans les rapports de ces différentes sciences qui se complètent et s'épaulent, le biologiste a toujours à intervenir car c'est à lui, en fin de compte, que revient la mission d'en tirer parti dans la pratique.

Aux prises avec la nature dans toute sa complexité et du fait des innombrables inter-relations et inter-actions qui en résultent, la majorité des biologistes ont à faire oeuvre d'analystes; cette position leur donne la charge

de signaler à leurs collègues des sciences voisines les faits qui ne sont plus exclusivement de leur ressort et que leur révèle l'étude des mouvements de population.

Mais parallèlement à ce travail constant d'analyste et d'informateur, il faudra que certains biologistes fassent la synthèse des connaissances acquises, sans laquelle l'application garderait le caractère empirique que nous lui avons connu pendant si longtemps. L'entomologiste economiste ne doit jamais perdre de vue le but de sa mission. En acceptant le rôle ingrat de coordinateur, le biologiste assume des responsabilités, mais s'il connaît parfaitement son metier, il en sera tôt ou tard récompensé par les progrès qui en résulteront. Il appartient aux directeurs des services intéresses de confier cette mission aux spécialistes qui, par leur vaste culture, leur expérience et leur autorité bienveillante ont le plus de dispositions à exercer ce rôle fondamental en Entomologie appliquée.

Conclusions

Si nous jetons un regard en arrière, nous mesurons le chemin parcouru depuis la période lointaine où quelques savants hollandais s'efforçaient de comprendre la vie des insectes. Comme le soulignait L.O. HOWARD dans son discours présidentiel du IVe Congrès international d'Ithaca, partout l'homme est aux prises avec l'Insecte, il n'a pas fallu moins de trois cents ans de recherches pour que „le règne de l'Homme" s'impose. C'est grâce aux efforts persévérants des Biologistes qu'il est arrivé, mais il ne s'est affirmé que parce que leur travail évolue sans cesse. Aux recherches sur les espèces, ont succédé les études sur le milieu et la faune, puis celles sur les individus et les populations.

Aux méthodes d'autrefois, qui se faissaient dans l'ombre d'un laboratoire, avec quelques instruments de précision et quelques cages d'élevage s'en sont substituées d'autres, où le travail individuel a perdu beaucoup de son importance, tant les horizons sont devenus vastes et hors de sa portée; on a constitudes équipes de chercheurs où chacun a une tâche assignée; on est allé sur le terrain pour étudier l'insecte dans son milieu; l'automobile, l'avion, l'hélicoptère ont complété le traditionnel filet à papillons.

On a introduit en biologie les mesures pour essayer de déceler les faits essentiels qui échappaient jusque là aux investigations et l'on s'est efforcé de définir des corrélations parfois même des lois.

Le Biologiste s'est déchargé peu à peu des fonctions annexes qui alourdissaient sa tâche, laissant aux physiologistes et aux toxicologues, mieux préparés aux recherches de cet ordre, le soin d'en pénétrer les secrets. La Toxicologie a pris en Entomologie appliquée une importance qui n'ira qu'en grandissant, car elle-même conditionne une science nouvelle, la Phytopharmacie, actuellement en plein épanouissement.

L'an prochain, en septembre 1952, se tiendra à Paris sous l'égide de la F.A.O. le IIIe Congrès international de Phytopharmacie. Grâce aux accords interprofessionnels qui ont été pris, ce Congrès doit constituer une des

manifestations les plus importantes qui aient jamais été organisées dans le domaine de la lutte chimique contre les insectes, qui ne représent cependant qu'une partie de son programme. Nous avons accepté l'un et l'autre de collaborer à son organisation et invitons les entomologistes du monde entier à y participer.

En raison de l'étendue et de la diversité des problèmes posés par la lutte chimique, nous estimons en effet que l'heure est venue pour les organisations internationales de se répartir les tâches. C'est pourquoi nous avons été d'accord avec le Comité pour demander que les Congrès d'Entomologie gardent à leur programme, en dehors de la lutte biologique, les études relatives aux conditions physiologiques et biologiques d'application, aux recherches des époques favorables de traitements, et aux incidences fauniques, mais réservent aux Congrès de Phytopharmacie-plus qualifiés-: les études relatives aux propriétés chimiques ou physiques ou physico-chimiques des produits, aux méthodes d'analyse, aux compatibilités ou aux incompatibilités, aux techniques d'essais, aux modes d'action ou d'application, à la réglementation et à l'économie des traitements.

Nous savons combien est délicat l'établissement de frontières entre deux disciplines voisines, mais si nous voulons renforcer l'intérêt de nos réunions, il faut d'une part que les organisateurs des Congrès s'entendent à l'avance sur la nature et la répartition des matières, et d'autre part qu'ils prévoient, comme l'a fait le Secrétariat de ce Congrès, des symposia, où seront mises à l'ordre du jour les grandes questions d'actualité. La but des rencontres internationales doit être, il ne faut pas l'oublier, de concourir à l'amelioration par les voies les plus diverses de la condition humaine.

La répartition des attributions, qui devient de plus en plus nécessaire, n'implique ni l'isolement ni un cloisonnement des activités. La biologie a désormais un tel rôle dans le concert des sciences appliquées que dans les questions qui nous préoccupent ici l'Entomologiste biologiste en deviendra souvent le Deus ex *machina.* Si chacun doit apporter sa pierre à l'édifice, le progrès ne repose pas sur des matériaux épars, simplement justaposés, mais sur des acquisitions solides et des travaux coordonnés, pour lesquels il faut des organisateurs scientifiques compétents et désintéressés.

LE POLYMORPHISME DES TERMITES ET LA DETERMINATION DES CASTES

par
Pierre P. GRASSÉ
Paris, France

Les Isoptères, Insectes privés de métamorphoses, modèlent peu à peu leur forme au cours d'un développement post-embryonnaire entrecoupé de mues.

A partir d'un même type larvaire se différencient, au cours du développement post-embryonnaire, diverses catégories d'individus qui constituent ce que l'on appelle des *castes*, lesquelles sont, classiquement, désignées sous les noms de sexués, d'ouvriers et de soldats, les deux dernières étant normalement exclues de la reproduction. Si pour ce qui est de la caste des soldats et des sexués aucune contestation n'est possible, il en va autrement de celle des ouvriers dont le statut varie avec chaque famille.

En 1949, j'ai donné dans le Traité de Zoologie, Tome IX, une mise au point de la question qui fait l'objet de la présente conférence, mais, depuis cette date, les travaux de mes élèves et de moi-même ont notablement fait progresser nos connaissances. Afin de dresser un bilan général de celles-ci, je me permettrai de rappeler dans ses grandes lignes l'organisation sociale des Isoptères.

Constitution des sociétés et différenciation normale des castes.

Constitution sociale et différenciation des castes variant notablement au sein des Isoptères, nous devons examiner chaque famille séparément et noter les particularités marquantes.

Famille des Calotermitidae

Les sociétés s'y composent de larves, de nymphes (1), de soldats, de sexués imaginaux, auxquels viennent s'adjoindre, à une époque précise de l'année, une foule d'imagos ailés, future essaimants.

Les larves nouveau-nées, aptères, aveugles, blanches, sont identiques entre elles. Elles subissent des mues; chez *Chlotermes flavicollis*, pour prendre un exemple, elles acquièrent des fourreaux alaires à partir du 4e stade et sont alors désignées sous le nom de *nymphes*. Leur appartenance à la caste des reproducteurs est signalée extérieurement par ces fourreaux alaires et par des ébauches oculaires. Après 7 mues, la nymphe donne l'imago, ailé et pigmenté, capable d'essaimer. Ce développement s'étale sur au moins deux années; nous verrons plus loin les principaux facteurs qui le conditionnent.

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*) Conventionnellement, nous reserverons le nom de nymphes aux individus qui, n'ayant pas encore achevé leur developpement, portent des fourreaux alaires, si courts soient-ils.

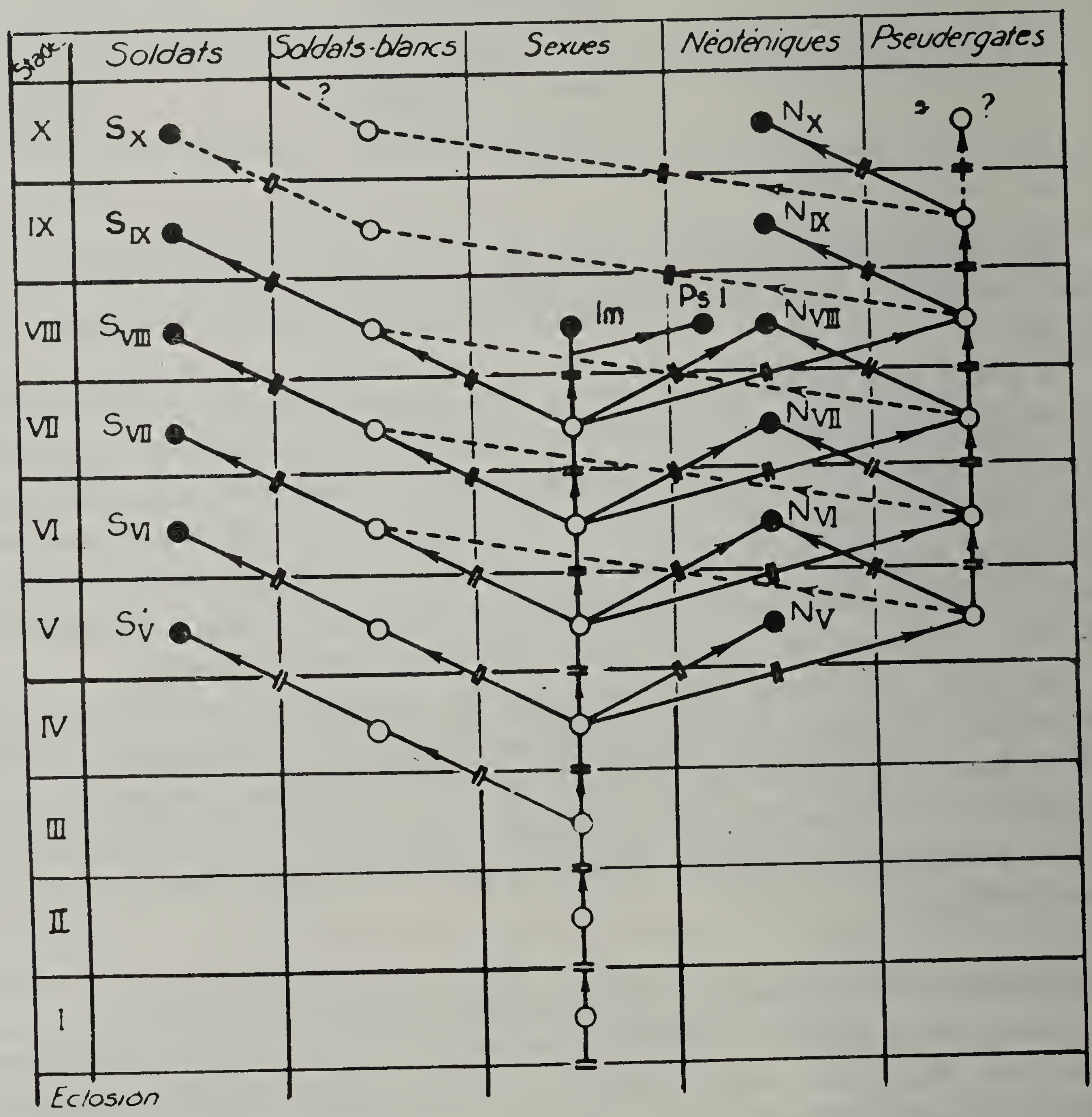

Fig. 1. Développement des castes chez *Calotermes flavicollis*. *S*, soldats; *N*, néoténiques; *Im*, imago; *Ps*, pseudimago (d'après P.P.GRASSÉ et CH.NOIROT).

L'imago ne subit plus de mue, quelle que soit sa destinée.

A partir du 3e stade, la larve peut donner naissance à une forme toute différente à un *soldat-blanc*, qui annonce le futur soldat parfait et est remarquable par ses longues mandibules, mais elle demeure blanche et molle. Au bout d'un certain temps, le soldat-blanc mue et devient le soldat adulte, forme définitivement fixée. Soldat-blanc et soldat parfait sont nourris par les larves actives.

Chez les Calotermitidae, normalement, les soldats proviennent des nymphes, c'est à dire d'individus appartenant à la caste des sexués. Mais, il faut remarquer que la transformation se fait à partir d'individus de stades différents et celà, dans les conditions naturelles, en *fonction de l'âge et de la valeur numérique de la population.*

Dans les sociétés débutantes, comptant moins de 20 individus (1ère cou

vée de la 1ère année), le premier soldat qui apparaît est de petite taille et ne possède que 12 articles antennaires. Il provient d'une larve du 3e stade. La termitière, en prenant de l'âge, se peuple et acquiert de nouveaux soldats qui dérivent de nymphes du 4e, 5e, 6e et 7e stades. Lorsque la dérivation s'effectue aux dépens de nymphes à fourreaux alaires bien marqués, le soldat porte sur ses méso-et métanotum les traces de ceux-ci qui trahissent son origine.

Une régulation de la taille s'opère et on n'observe que de faibles différences de dimensions entre les soldats issus de nymphes de stades variés; le nombre des articles antennaires va de 14 à 18 articles, sans qu'il y ait une corrélation entre lui et la taille totale. Nous tenons pour peu probable que dans une société adulte, les soldats proviennent de jeunes larves; cette éventualité est l'apanage des sociétés débutantes.

Les belles recherches de KALSHOVEN (1930) sur *Neotermes tectonae* de Java s'accordent avec les résultats obtenus par nous-même (GRASSÉ et NOIROT 1946) sur *Calotermes flavicollis;* notamment avec le fait que des larves, morphologiquement indistinctes, ont une destinée influencée par l'âge et la valeur numérique de la population. Au fur et à mesure que la société vieillit, les soldats sont produits par des larves ou des nymphes appartenant à des stades de plus en plus avancés.

Famille des Termopsidae

Les sociétés de cette famille ont la même composition que celles des Calotermitidae et la différenciation des castes, bien étudiée par HEATH (1927-1928) et surtout par LIGHT (1943-1944), s'y déroule d'une façon très analogue. Toutefois, les auteurs américains ont décrit, dans les termitières comptant 3.000 individus et plus, une catégorie de nymphes à grosse tête, à fourreaux alaires plus ou moins développés, qui seraient résolument engagées dans la caste soldat; mais ces larves, qui appartiennent au 7e stade, ont aussi la possibilité de développer leurs fourreaux alaires et de devenir des imagos ailés. Nous estimons qu'elles correspondent aux *pseudergates* découverts par GRASSÉ et NOIROT (1947) chez les Calotermitidae.

Famille des Rhinotermitidae

Cette famille s'avère d'une composition hétérogène; nous la croyons polyphylétique.

Chez *Prorhinotermes simplex* (MILLER 1942), la différenciation des castes se déroule à peu près comme chez *Calotermes:* une seule et même lignée de larves donnerait les soldats, les imagos ailés et les ouvriers. Les imagos, fait aberrant, ne seraient précédés que par un seul stade nymphal. Les soldats, comme chez *Calotermes,* sortiraient de larves ou de nymphes de sexués, mais aussi d'ouvriers. Comme il est extrêmement difficile de séparer les larves actives de ces derniers, cette assertion appelle des remarques qui seront exprimées à propos du statut de l'ouvrier.

La sous-famille des Heterotermitinae, avec le genre *Reticulitermes,* a donné lieu à de nombreux travaux, souvent très poussés.

De l'oeuf sortent des larves semblables morphologiquement, qui, après leur 2e mue, se différencient en 2 catégories, se distinguant par les dimensions de la tête (données de GRASSI et SANDIAS 1893, HARE 1934): l'une, à grosse tête, est celle des futurs neutres, ouvriers et soldats, l'autre, à petite tête, celle des sexués. Les travaux de MONTALENTI (1929), de BUCHLI (1950) ont montré que la production des soldats se fait à partir de larves du 3e stade dans la colonie débutante, et que, par la suite, ceux-ci dérivent de larves plus âgées. Dans les conditions naturelles, la dérivation à partir de nymphes ne se présente pas. Les nymphes (5 stades nymphaux) donnent les imagos qui exigent un nombre fixe de mues, soit 7.

Le cas des Coptotermitinae s'apparente, semble-t-il, au précèdent, mais avec une caste d' ouvriers mieux délimitée.

La famille des Psammotermitidae, avec son unique genre *Psammotermes,* se fait remarquer par l'extrême variabilité de la taille des soldats et des ouvriers. Chez *Ps. hybostoma,* les auteurs ont décrit tantôt 2, tantôt 3 catégories de soldats. Dans un mémoire non encore publié, Mademoiselle CLÉMENT a montré qu'il est impossible de parler de 2 ou 3 catégories car, lorsque la statistique porte sur un grand nombre d'individus, on passe insensiblement du grand soldat à tête carrée au petit soldat à tête rectangulaire. En réalité, les courbes de fréquence font apparaître que certaines dimensions se rencontrent plus souvent que d'autres, et de ce fait, statistiquement, une discontinuité peut être admise au sein de la caste des soldats, avec deux catégories: les petits et les grands. En outre, les rapports d'allomètrie ne sont pas les mêmes dans les deux, ce qui contribue à les séparer. Au polymorphisme des soldats semble correspondre celui des ouvriers. Notamment dans une colonie adulte de *Ps. hybostoma* existent, en nombre plutôt réduit, des ouvriers d'une très grande taille et dont on ne retrouve l'équivalent chez aucun autre Termite. Les grands soldats proviennent de ces ouvriers, et les petits des ouvriers de taille moins grande. Le problème se pose, comme pour les *Reticulitermes,* de savoir où commence et où finit la caste des ouvriers.

Famille des Termitidae

Cet énorme ensemble, qui englobe la totalité des Termites supérieurs dépourvus de Protozoaires symbiotiques, est très hétérogène. Cette hétérogènéité se réflète nettement dans le mode de différenciation des castes. Les travaux anciens de KNOWER (1894), EMERSON (1926), BATHELLIER (1927), sont aujourd'hui largement dépassés grâce aux belles recherches de Charles NOIROT.

Deux faits méritent d'être mis en lumière:

1. Les larves nouveau-nées sont apparemment identiques; après la 1ère mue, elles donnent 2 catégories d'individus:
   a. des nymphes à tête étroite, à fourreaux alaires très courts, mais nets.
   b. des larves de neutres à tête plus large, sans fourreaux alaires.
2. Les larves de la catégorie des neutres n'évoluent pas toujours de la

même manière, selon qu'elles appartiennent à l'un ou l'autre sexe (NOIROT 1951). BATHELLIER (1927) avait soutenu, avec documents à l'appui, que, dès leur naissance, les larves de Termitidae se divisaient en 2 catégories selon la taille des organes génitaux: les unes à grosses gonades représentaient les futurs sexués, les autres à petites gonades, les futurs neutres. En vérité, *les grosses gonades sont des ovaires, les petites des testicules.* NOIROT a pu le démontrer en déterminant les positions du gonopore: base de 7e sternite chez les femelles, base du 9e chez les mâles. Le gonoducte donne sur le sexe de meilleurs renseignements que la gonade proprement dite, dont les dimensions sont assez variables.

Ces généralités posées, passons à l'étude des cas particuliers.

A. Le développement de la lignée des sexués se déroule comme chez les Termites inférieurs, mais exige une mue de moins, 7 stades au lieu de 8.

B. Le développement de la lignée des neutres ne s'opère pas indentiquement chez les Macrotermitinae (Termites champignonistes) et chez les autres Termitidae.

Nasutitermitinae

Exemple: Nasutitermes arborum (fig. 2).

Après la 1ère mue, les larves du 2e stade sont de taille très différente: les petites appartiennent au sexe mâle, les grandes au sexe femelle. Les petites, en muant donnent les petites ouvriers qui muent, à leur tour, une ou 2 fois. Le petit ouvrier I, normalement, donne le soldat-blanc; le petit ouvrier II semble posséder la même faculté. Les grandes larves engendrent les grands ouvriers, tous du sexe femelle. Au total: les soldats et les petits ouvriers sont mâles, les grands ouvriers femelles. Expérimentalement, il a été possible d'obtenir des soldats à partir des grands ouvriers I et II.

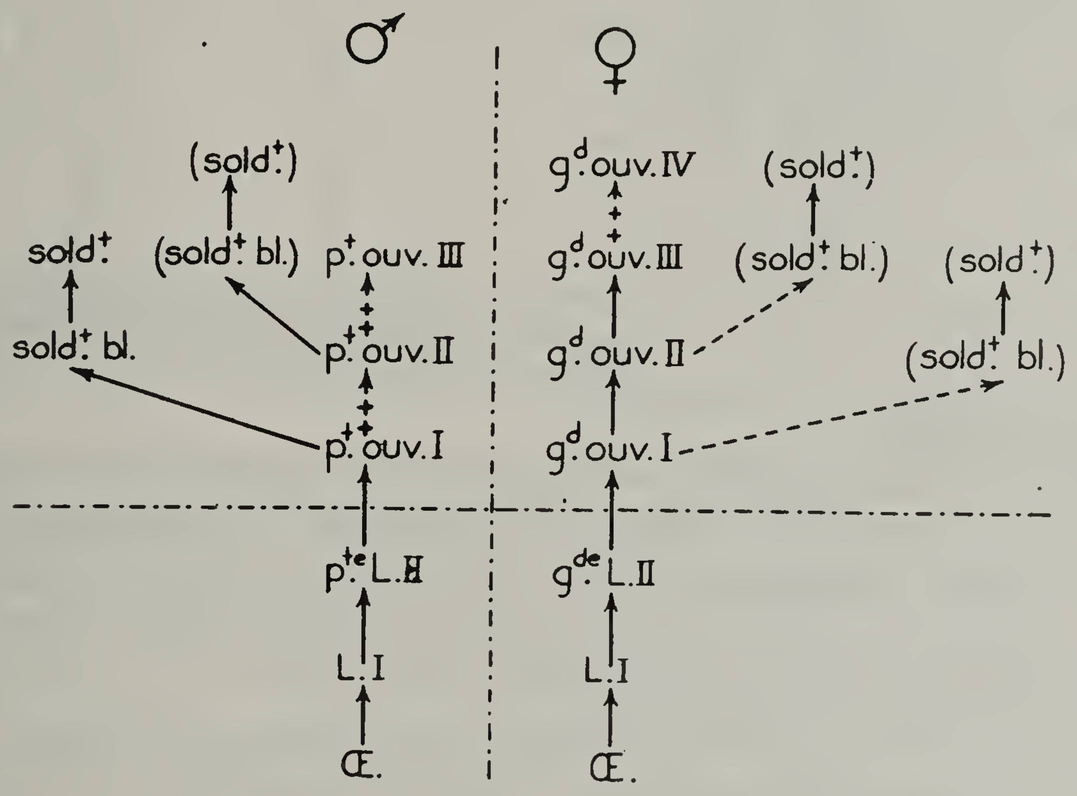

Fig. 2. Développement des castes chez *Nasutitermes arborum* (d'après les données de CH. NOIROT).

Amitermitinae

Exemple: Amitermes evuncifer (fig. 3).

Les larves mâles et femelles sont de même taille; les ouvriers I, mâles et femelles, sont capables de donner des soldats; on compte, dans la termitière, autant de soldats mâles que de soldats femelles. Les ouvriers peuvent muer deux ou trois fois pour aboutir à des ouvriers du stade IV.

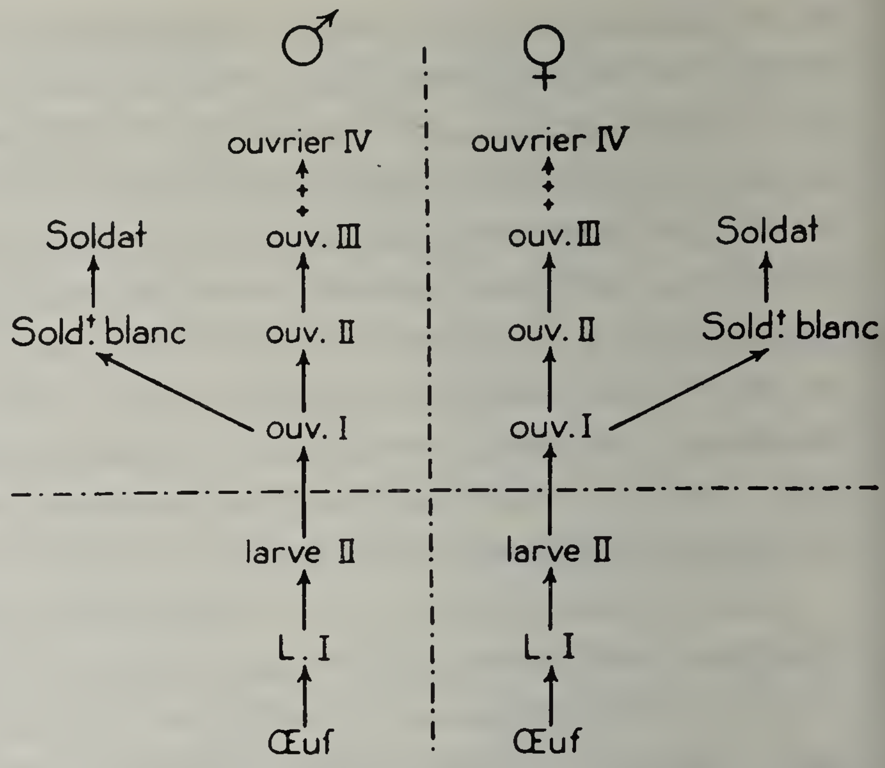

Fig. 3. Développement des castes chez *Amitermes evuncifer* (d'après les données de Ch.NOIROT).

Microcerotermitinae

Exemples: Microcerotermes fuscobibialis, M. parvus (fig. 4).

Deux catégories d'ouvriers; les grands sont femelles, les petits mâles. Les soldats derivent normalement des grands ouvriers I, ils sont donc femelles. Il semble que le petit ouvrier I, mâle, peut, dans des conditions expérimentales, donner des soldats.

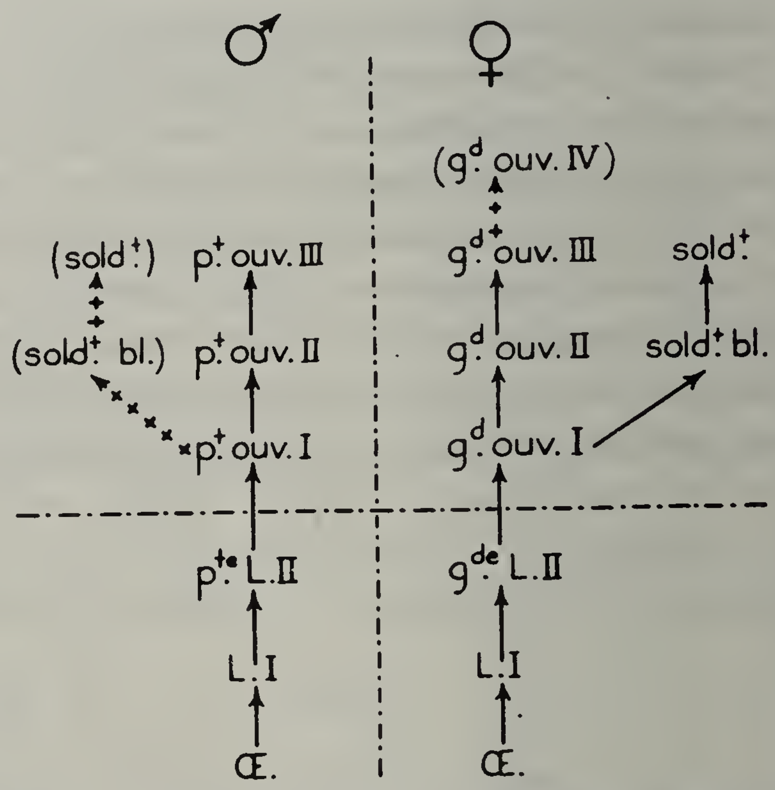

Fig. 4. Développement des castes chez *Microcerotermes fuscotibialis* et *M. parvus* (d'après les données de Ch.NOIROT).

Mirocapritermitinae

Dans cette sous-famille, les ouvriers des stades II et III tendent à disparaître. Les soldats dérivent tous des ouvriers I du sexe femelle.

Le cas nous paraissant le plus primitif est celui des *Mirotermes* (Exemples: *M. hopes* et *M. baculi*, fig. 5). Les ouvriers muent une ou deux fois (cette dernière éventualité paraît rare).

Chez les *Cubitermes, Procubitermes,* (fig. 6), l'ontogenèse se simplifie, tous les ouvriers, quel qu'en soit le sexe, appartiennent au même stade et seules les femelles engendrent des soldats.

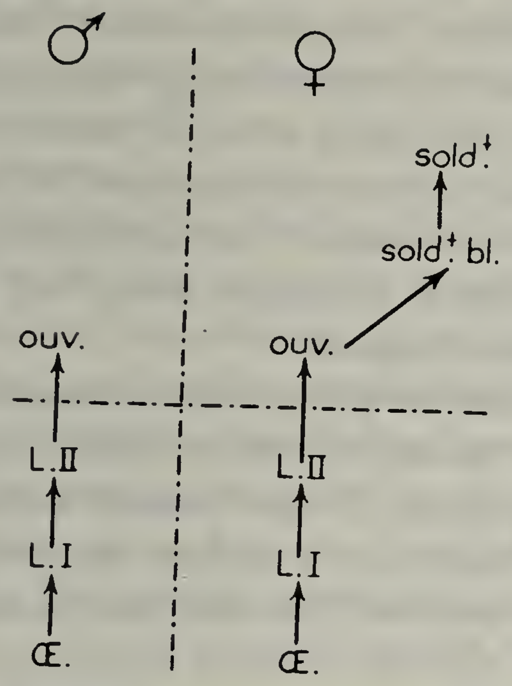

Fig. 5. Développement des castes chez *Mirotermes hospes* et *M. baculi* (d'après les données de CH. NOIROT).

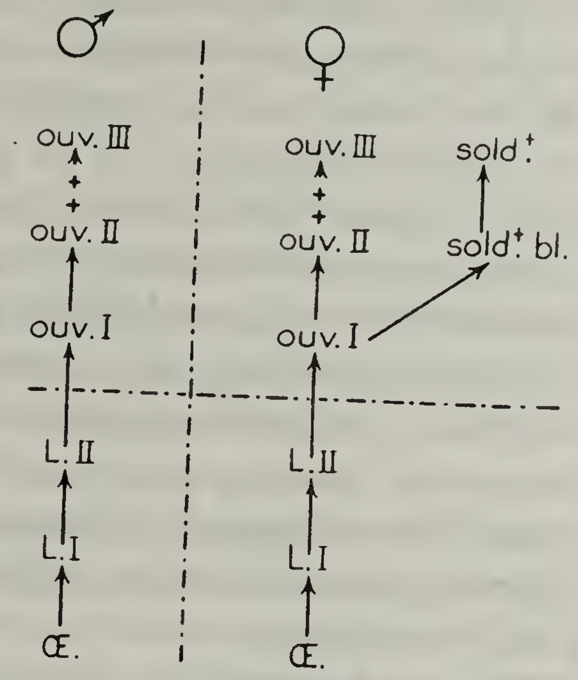

Fig. 6. Développement des castes chez *Procubitermes* et *Cubitermes* (d'après les données de Ch. NOIROT).

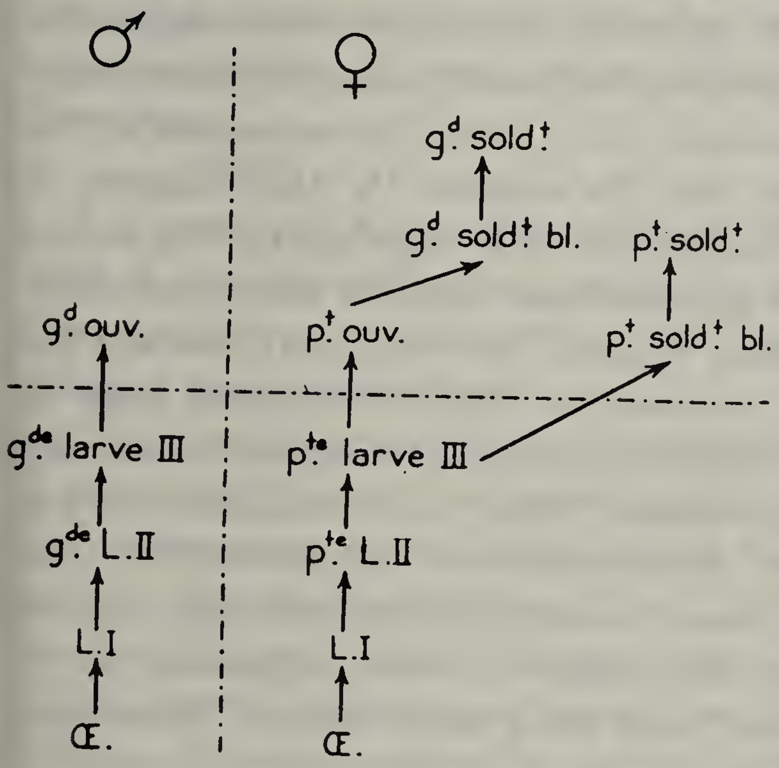

Fig. 7. Développement des castes chez *Bellicositermes natalensis* et *Ancistrotermes crucifer* (d'après les données de CH. NOIROT).

Cas des Macrotermitinae (fig. 7).

Il se distingue des précédents par le fait que les stades larvaires sont au nombre de 3: les larves mâles sont les plus grandes et engendrent les grands ouvriers.

Les petites larves, toutes femelles, ont deux possibilités:

a. soit de muer en donnant un petit ouvrier; parmi ceux-ci certains muent encore une fois et deviennent un grand soldat-blanc qui, à son tour, devient grand soldat.

Ici, le dimorphisme des soldats ne correspond pas au dimorphisme sexuel. Tous les soldats, quelle que soit leur taille, sont femelles, mais ne dérivent pas du même stade.

Voilà, très rapidement esquissé, ce que nous savons de la différenciation des castes chez les Termites. Des lacunes importantes demeurent dans nos connaissances: nous ignorons tout du développement post-embryonnaire des *Mastotermes*, formes relictes du plus haut intérêt, des Hodotermitidae, des *Acanthotermes* et *Pseudacanthotermes* chez lesquels le polymorphisme des soldats atteint son apogée. En outre, à s'en tenir à cet exposé statique, on risque de n'avoir qu'une idée simplifiée, et partant inexacte, du polymorphisme chez les Isoptères.

La notion d'ouvrier.

Tout d'abord, remettons en question la notion d'ouvrier. Les termitologues, jusqu'ici, ont été d'accord pour admettre que les Calotermitidae et Termopsidae n'ont pas d'ouvriers et que les fonctions de ceux-ci sont accomplies par des larves ou des nymphes d'âges variés. En 1947, GRASSÉ et NOIROT ont appelé l'attention sur de grands individus, aptères ou porteurs de fourreaux alaires très courts, placés nettement en dehors du développement post-embryonnaire normal. Ces individus peuvent demeurer sous cet état pendant des temps très longs; ils ont une double origine:

l'une ascendante, les larves grandissent sans acquérir de fourreaux alaires. Des sociétés composées exclusivement de larves du 4e stade, rigoureusement aptères, nous ont donné, après la mue: 1^e^ des sexués néoténiques, 2^e^ des nymphes à fourreaux alaires, 3^e^ des larves aptères qui se sont maintenues sous cet état, même lorsqu'elles ont mué; ce sont des *pseudergates* ascendants.

l'autre descendante est de beaucoup la plus intéressante et pose un important problème de morphogenèse. Dans des sociétés composées exclusivement de nymphes du 7^e^ stade, on obtient, entre autres individus, de *grosses larves aptères;* la mue a eu pour effet de raccourcir ou de faire disparaître les fourreaux alaires et même les ébauches oculaires, tout en laissant inchangé le nombre des articles antennaires; *elle a donc fait accomplir à l'individu un indéniable retour en arrière, elle l'a rajeuni,* l'a dédifférencie. A cause de ces caractères, nous la qualifions de *mue régressive.* Ces larves du 8^e^ stade ont devant elles plusieurs possibilités: subir de nouvelles mues et perdre ainsi toute trace de fourreaux alaires, ou bien, si la société est complète et équilibrée, se stabiliser en quelque sorte et demeurer sous le même état; elles sont alors les équivalents exacts des ouvriers et ont été nommées par nous *pseudergates descendants.* Elles ont cependant des potentialités que le déséquilibre social peut éveiller et sur lesquelles nous reviendrons dans un instant. Comme nous l'avons précédemment dit, c'est à nos *pseudergates* qu'il faut rapporter les grosses larves dépassant le 8^e^ stade, qui ont été observées par LIGHT dans les grands nids de *Zootermopsis.*

Chez *Reticulitermes,* il était admis que la caste des ouvriers était bien délimitée et stable. En vérité, il y est toujours malaisé de séparer de ceux-ci les larves âgées, aptères. Comme je l'ai montré avec mes élèves NOIROT, CLÉMENT et BUCHLI (1950), les ouvriers ne sont pas des individus irrémédiablement fixes, ils conservent, lorsque la société est perturbée, la possibilité de muer et d'engendrer des soldats et des sexués de remplacement.

D'après BUCHLI (1951), la transformation des ouvriers des stades 4 et 5 en néoténiques s'opère en deux temps: une première mue les change en „*pseudonymphes*", à très courts fourreaux alaires, lesquelles, par une 2e mue, donnent les sexués néoténiques à fourreaux alaires généralement très réduits.

Si l'on s'en rapporte aux travaux inédits de Mademoiselle CLÉMENT, il

semble également que chez les *Psammotermes*, il est difficile de parler d'ouvriers définitifs.

En résumé, chez les Termites inférieurs, l'ouvrier apparaît comme un stade morphologiquement larvaire relativement stabilisé qui possède, lorsque la société est placée dans certaines conditions, la possibilité de se transformer en soldat ou en sexué néoténique.

Chez les Termitidae, les faits se présentent un peu différemment et il y a lieu de distinguer les ouvriers stables de ceux qui donnent les soldats. Dans les conditions naturelles, chez les *Nasutitermes*, les ouvriers femelles sont stables et ne donnent pas de soldats; chez les *Microcerotermes*, ce sont les ouvriers mâles, etc. . .; le type le plus parfait d'ouvrier stable est le grand ouvrier des *Bellicositermes* et des *Ancistrotermes*.

Mais, au moins sous certaines conditions (sociétes à rapports numériques entre les castes déséquilibrés, sociétés rendues artificiellement homogènes . . .), les ouvriers réputés stables des *Microcerotermes* (ouvriers mâles), des *Nasutitermes* (ouvriers femelles) sont capables de donner des soldats. Pour les *Amitermes*, il semble en été de même.

Jusqu'ici, aucun fait ne nous autorise à dire qu'un ouvrier de Termite supérieur puisse donner un sexué de remplacement; l'état fort réduit de ses gonades semble, à priori, rendre difficile, sinon impossible, une telle transformation.

Le premier fait relatif au pouvoir régulateur des termitières a été découvert il y a une soixanteine d'années par Frits MÜLLER et par B.GRASSI. Une société privée de ses sexués imaginaux pourvoit, généralement à bref délai, à leur remplacement.

Chez les Calotermitidae, Termopsidae et Rhinotermitidae, tous les stades, à partir du 3^{e}, sont susceptibles de se transformer en sexués fonctionnels qui conservent à peu près l'aspect larvaire ou nymphal et, qui pour cette raison, sont dits néoténiques.

GRASSÉ et NOIROT (1946), pour *Calotermes flavicollis*, puis BUCHLI (1950, 1951), pour *Reticulitermes*, ont précisé les conditions dans lesquelles s'opère le remplacement et montré qu'une mue précède la transformation. Il semble que tous les individus qui se trouvent dans un certain état physiologique et, probablement à un temps donné de la prochaine mue, sont susceptibles de devenir des néoténiques. Tout néoténique, dans le cas des larves et des nymphes, a un soma stabilisé mais, en revanche, son germen, libéré de toute entrave, s'accroît à grande vitesse et devient fonctionnel. Ce même germen dans les larves et nymphes d'une société normale, avec roi et reine, ne se développe que très lentement et, dans les essaimants eux-mêmes, il est encore loin d'avoir atteint sa complète maturité.

Cette production de néoténiques est possible, semble-t-il, chez tous les Termites, à l'exception des Macrotermitinae.

En vérité, les Isoptères peuvent utiliser à titre de sexués de remplacement des formes imaginales. Nous distinguerons deux cas :

1. *Cas des Termites inférieurs.* Le processus est exceptionnel, et les sociétés orphelines auxquelles on adjoint un couple imaginal n'acceptent pas celui-ci. Des nymphes du dernier âge, dans certaines sociétés orphelines, poursuivent un développement normal et rien ne les distingue de leurs congénères, mais après la mue, elles ne brunissent que très légèrement, seuls leurs yeux noircissent; leurs ailes, imparfaitement dépliées, ne se rompent pas selon la ligne de suture et sont déchirées par les ouvriers. Ces individus ont été qualifiés par nous de *pseudimagos*. Ils ne sortent pas du nid et sont aptes à accomplir, dans celui-ci, leurs fonctions génétiques. Il y aurait beaucoup à dire sur la transformation profonde que subit le comportement de ces pseudimagos comparé à celui des essaimants. Nous n'avons pas le temps de nous y attarder.

2. *Cas des Termites supérieurs.* NOIROT (1950) a observé que, chez les *Anoplotermes*, dans les fragments de société privés de sexués, certains imagos ailés deviennent des reproducteurs. Le phénomène a été retrouvé chez des *Nasutitermes*, des *Mirotermes*, des *Cubitermes*. Tout récemment (1949), COATTON l'a signalé chez les Termites champignonnistes (Macrotermitinae). Nous ne connaissons pas encore, en dehors de la suppression des sexués fonctionnels, les conditions qui doivent être réunies pour que cette utilisation de sexués, normalement destinés à l'essaimage, se produise.

La détermination des castes

L'étude minutieuse révèle que chez les Calotermitidae, Termopsidae et Rhinotermitidae, toutes les castes proviennent d'un même type de larve, qu'aucun caractère morphologique ne permet de séparer en catégories correspondant aux sexués, aux ouvriers, aux soldats.

En constituant systématiquement des sociétés dites homogènes, composées d'individus de la même sorte et du même stade, nous avons fait extérioriser par ceux-ci des caractères, qui, dans les conditions normales, demeurent cachés. Ainsi les sociétés de nymphes du 7^e^ stade de *Calotermes*, stade qui précède l'apparition des imagos, deviennent en quelques semaines des sociétés hétérogènes, équilibrées où toutes les castes sont représentées: certaines nymphes continuent à évoluer vers la forme ailée tout comme si elles se trouvaient dans une termitière normale, d'autres subissent une mue régressive et se transforment soit en sexués néoténiques fonctionnels, soit en pseudergates lesquels ultérieurement pourront donner des soldats et même repartir vers la production de sexués ailés.

Des résultats du même ordre ont été obtenus par MILLER (1942) sur *Prorhinotermes simplex*. Avec *Reticulitermes*, on a pu aller plus loin encore: a. les ouvriers ont la possibilité de donner des néoténiques et des soldats (GRASSÉ, NOIROT, BUCHLI et CLÉMENT 1950); b. les nymphes peuvent devenir des sexués néoténiques des pseudergates qui, ultérieurement, se transforment en soldats.

Devant de tels faits, il n'est guère possible de parler d'un déterminisme blastogénique de la caste. Le milieu social, notamment par sa composition

qualitative et par les rapports numériques entre les castes, a un rôle capital sur la destinée de l'individu. Le groupe social, selon qu'il contient telle ou telle catégorie, engage l'ontogénèse post-embryonnaire dans une voie ou dans une autre.

Autrement dit, si l'on considère une société normale, au sein de laquelle les castes se trouvent dans des proportions numériques définies, toute rupture d'équilibre sera compensée par la production des catégories manquantes en engageant des individus dans une voie qui ne leur était pas destinée; c'est à ce phénomène que nous avons donné le nom de *régulation sociale*. Ce phénomène traduit ainsi les potentialités physiologiques et morphogénétiques des individus qui n'ont pas atteint ce que nous qualifierons de *forme stable*.

A quoi tient alors l'équilibre numérique entre les castes dans les sociétés normales. Depuis PICKENS (1932), on parle d'une inhibition due à une sécrétion des sexués fonctionnels, laquelle, absorbée et distribuée entre tous les habitants d'une même société, aurait pour effet d'inhiber le développement des organes génitaux; il y aurait ainsi une gonohormone sociale. Il faut en imaginer une autre pour les ouvriers et une troisieme pour les soldats, avec, bien entendu, des catégories pour chaque sorte d'ouvriers ou de soldats lorsque la caste se découpe en subdivision.

Les essais, faits par LIGHT et ses collaborateurs et par nous-même, pour modifier la composition de la termitière en faisant ingérer ou en injectant à ses habitants les extraits d'individus de telle ou telle caste, se sont tous soldés par des échecs. Par exemple, dans une société privée de sexués ou de soldats, l'administration de tels extraits n'empêche pas la formation de sexués ou de soldats de remplacement.

En mettant en contact, sans permettre les échanges trophallactiques, deux groupes de *Calotermes* l'un avec l'autre, sans sexués, le groupe orphelin acquiert dans les délais normaux ses néoténiques, mais il les détruit au fur et à mesure qu'il les forme (j'ai fait cette expérience, il y a quelque 12 ans; elle a été répétée dans mon laboratoire par LÜSCHER). Ainsi, l'inhibition est bien levée, et la différenciation des sexués peut se faire, mais un trouble du comportement intervient qui provoque le destruction des sexués néoformés. L'interprétation d'une telle expérience est difficile en soi, elle l'est d'autant plus que les résultats sont différents en utilisant des Termites d'autres espèces. Ainsi chez *Reticulitermes*, tous les sexués acquis par le groupe orphelin sont conservés; mais il y a plus: BUCHLI, à plusieurs reprises, a obtenu des sexués néoténiques en présence d'un couple royal fonctionnel. Si l'inhibition joue, et il nous paraît difficile d'en nier la réalité, elle dépend de causes encore inconnués aussi est-il prématuré de parler d'ecto- ou de sociohormones, bien que l'existence de telles substances soit vraisemblable.

Nous avons volontairement laissé de côté les Termitidae, qui n'ont donné lieu qu'a peu d'expériences. A leur propos, nous ne savons que deux faits:

1. des sexués néoténiques peuvent être formés à partir de larves appartenant à la caste des reproducteurs.

2. des ouvriers qui, dans une termitière normale, ne donnent pas de soldats peuvent le faire si la société est privée de ceux-ci (NOIROT 1951).

Les deux castes, sexuée et neutre, semblent être déterminées très précocement dès l'oeuf, peut-être par quelques facteurs génétiques. La formation des soldats, comme chez les Termites inférieurs, mais ici à partir de neutres, a tous les caractères d'une épigenèse.

Mais il y a un facteur, encore non étudié, qui joue dans les conditions naturelles un rôle très important dans la production des castes, c'est le rythme des saisons. Par exemple, chez les *Bellicositermes,* genre tropical, les sexués sont formés en masse à un moment précis de l'année, de telle sorte qu'au début de la saison humide, tous les sexués sont sous la forme ailée et sortent du nid pour essaimer. Il est indéniable que, dans la plupart des Termitières, la production des diverses castes s'opère selon un rythme en rapport avec celui des saisons et, comme dans le cas de diapauses, il se peut qu'il soit fixé héréditairement.

Nous terminons cette conférence sur un point d'interrogation et c'est très bien ainsi, car nos connaissances sur la biologie des Termites sont encore fragmentaires et souvent incertaines. Les Isoptères restent encore un des plus beaux et des plus riches domaines à explorer s'offrant à la curiosité des biologistes.

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THE MIGRATION AND DRIFT OF INSECTS AND ITS INTERNATIONAL ASPECT

by

C.B. WILLIAMS

Harpenden, Herts, England

When I first became interested in Entomology, nearly fifty years ago, considerable emphasis appeared to be laid on how little insects moved, and scarcely any on how far they moved.

The world of collectors of butterflies and moths was full of "localities" where certain insects could be found; and sometimes these areas were very limited. Much of my boyhood was spent on the sandhills of our Cheshire coast, near the city of Liverpool, where there were about eight miles of dunes, resembling the Dutch dunes along the North Sea coast at Bergen and Groet. These sandhills were the home of certain moths – such as for example the Geometrid moth *Nyssia zonaria* – and entomologists came from many parts of the country to obtain specimens. The insects were "confined" to these sand-dunes and to a very few similar localities round our coast.

Our only British Swallowtail Butterfly, *Papilio machaon,* was not uncommon on certain fenlands in Cambridge and Norfolk – but was extremely rare or absent anywhere else in the country – even only a few miles from its haunts. On our highest mountain, Snowdon, there was a small area – known only to a few – where a beetle *Chrysomela cerealis* L. could be found. Outside this small area one might collect for years without ever seeing a single specimen.

And such examples could be multiplied a thousand times both in my own country and in all other parts of the world.

There were recognised, of course, a few "unusual" cases; an insect might be found cocasionally far from its proper place; but these were the exceptions that proved the rule. We caught in Britain a few individuals of the butterfly *Vanessa antiopa* but, in spite of the fact that during the previous hundred years no egg, caterpillar or chrysalis had ever been found in our country, the idea that the insects had flown across the Channel or the North Sea was still dismissed by most entomologists as absurd.

During my training in Agriculture at the University of Cambridge about 1910, great importance was given to the "rotation of crops" as a measure for preventing insect outbreaks. If a particular crop was grown on one field in one year, it must not be grown on the same ground in the following year – but a field fifty yards away or even less, was much safer: apparently this distance was considered too much for most insects to cover. There are many good reasons for the rotation of crops, but I am beginning to believe that the prevention of insect outbreaks is not one of the more important of these.

However, even fifty years ago a change in outlook was beginning in many

parts of the world. A few bold entomologists had suggested that other insects as well as locusts were capable of moving hundreds of miles – the butterfly *Danaus plexippus* in North America – the moth *Alabama argillacea*, a great pest of cotton in North America – the butterflies *Pyrameis cardui, Colias croceus* and *C.hyale* in Europe – one by one came under suspicion as species which left their breeding places and moved across land and sea for hundreds of miles. At first it was considered quite impossible that these distances could be covered by their own efforts, and so the wind was drawn in to account for the movements; only when the wind had been tried and found wanting was the idea of deliberate migration in insects generally accepted. But even this has to be qualified – the movements were "overflow" movements from overpopulated areas, and in one direction without any return flight. It has taken the last twenty years to obtain evidence supporting the idea that Lepidoptera and possibly other insects can carry out regular to and fro seasonal movements (in the northern hemisphere towards the pole in the spring and towards the equator in the autumn), in a manner closely resembling the migration of birds.

The migrations of locusts are so well known that I will only refer to the fact that there are about half a dozen migrant species of major importance including the "migratory Locust" (*Locusta migratoria*) which ranges over much of Africa, Southern Asia and South-Eastern Europe – the "Desert Locust" (*Schistocerca gregaria* Forsk) in the Northern half of Africa and South-Western Asia – the "Red Locust" (*Nomidacris septemfasciata* Serv.) and the "Brown Locust" (*Locustana pardalina* Walk) in Tropical and Southern Africa – and the South American Locust (*Schistocerca paranensis*) in Central and South America.

The Rocky Mountain Locust (*Melanoplus mexicanus* Sauss.) of North America no longer appear in the great migrant swarms that were so devastating a century ago.

Among the Lepidoptera the Monarch butterfly, *Danaus plexippus*, is one of the greatest migrants in North America. In the summer it ranges as far north as Canada up to the level of Hudson Bay, but in the autumn all the butterflies fly southward – often in large groups – to Florida, the Gulf States, Mexico and southern California. Here they spend the winter in a state of semi-hibernation and then return north again in the spring, laying eggs as they go. The double journey, performed in this case by the same individuals, covers a distance of two or three thousand miles.

The "Painted Lady" (*Pyrameis cardui*), is another great migrant in many parts of the world. In America it appears to breed in large numbers during the winter in Western Mexico and Lower California, and from there in the spring there come great migrations – in some years of millions of butterflies – which invade the south-western States and fly northward as far as British Columbia, and north-eastward to cover most of the U.S.A. and even Eastern Canada and Newfoundland. The distance flown varies from over one thousand to nearly three thousand miles 2000-5000 kms). There is no ev-

idence of any survival in the United States or Canada during the winter, nor is there at present any evidence of a return to the south in the autumn.

In the Old World the same species breeds during the winter in the semi-arid areas of North Africa, and moves north, often in enormous numbers, each spring. The butterflies cross the Mediterranean without difficulty and fly north across Europe reaching the latitude of southern Britain or Holland about the beginning of June – but often going on far beyond this to the north of Scotland and even occasionally to Iceland. Further east in Finland they have been found in numbers well beyond the Arctic Circle. Again there is no evidence of winter survival in any stage anywhere except in the extreme south of Europe; but there is some evidence of an autumn movement to the south in small numbers. Once again the distance covered in the spring flight is not far from 1500 to 2000 miles.

In Europe the Cabbage-White Butterfly (*Pieris brassicae*), has a very different type of movement, but also covers distances of many hundreds of miles. It flies southward through Central Europe from some undetermined source in the Baltic area often passing through Germany in flights that resemble snowstorms. These flights are usually at the end of July or beginning of August, but there are records of smaller movements earlier in the year about the end of May. Offshoots of these flights fly across the North Sea and the English Channel and invade the East and South-East shores of England – and even these immigrations may consist of millions of individuals.

Turning next to the question of "Drift", we use this term for insects which are carried by wind currents apparently "against their will" or at least without effort on their own part. The insects in which this occurs are mostly smaller weak-flying groups such as Aphidae, Jassidae, small Hymenoptera and small Diptera, and the height and distance to which they can be carried in large numbers are quite upsetting to the older conception of insects keeping close to one spot.

Some years ago, in August 1924, large numbers of living Aphidae were found on the snow in Spitzbergen. They were identified as *Dilachnus piceae* Pg (nec Walker), a species that feeds on coniferous trees, and the nearest possible source was about 800 miles away; and of course there was no proof that they had come from the nearest locality (ELTON, 1925).

The first intensive study of insect drift was carried out in the U.S.A. by the use of sticky traps attached to aeroplanes (see GLICK 1939), Neuroptera and Lepidoptera were found up to 5000 feet; Thysanoptera and Heteroptera up to 11,000 feet; Coleoptera up to 12,000 feet and Hymenoptera, Diptera and Homoptera up to 14,000 feet. Even one wingless Collembola was caught at 11,000 feet! (1000 m =3300 ft.).

When one considers the strong winds at these high levels, and the time that must be taken for the insects to fall back to earth, it is easy to see to what great distances they may be carried before they again reach the ground.

In England the study of insect drift was first taken up by HARDY, MILNE and FREEMAN who attached nets to kite strings, to tall radio-masts, and

to the masts of steamers crossing the North Sea. In the latter case HARDY was able to show that on many fine summer days, in the air over the North Sea at least 50 miles from land, there were literally millions of insects, particularly Aphidae.

More recently the investigation has been continued in England by JOHNSON at Rothamsted Experimental Station by the use of nets and other traps attached to the cables of "barrage balloons". By this improved technique it is possible to get regular observations by day and night at levels up to over 1000 metres. By using suction traps – which draw a fixed volume of air through a vertical net by means of an electric fan – it is possible to get reliable estimates of insect density even when there is no wind.

At a height of 2000 feet on many warm summer days, in a net 3 feet (90 cms) across, JOHNSON finds up to 10 or even 20 Aphidae per hour – all alive; and when one considers the relatively microscopic portion of the air that is going through the net, the total number of insects up to this level must be reckoned in hundreds of millions.

Although the density of insect populations – that is to say the number in a fixed volume of air – is of course far greater near the ground, the amount of air which is not near the ground is so much greater that, according to JOHNSON's calculations, about 75% of the insects in the air on a warm summer day are found above 20 feet from the ground.

So we see that by active migration and by passive drift millions and millions of insects, of hundreds of species, and of almost all orders, are carried regularly tens, hundreds and occasionally thousands of miles. Many of these insects are pests – some on the other hand are beneficial.

Among the migrant pests are included of course all the Locusts and the Cabbage-White butterfly (*Pieris brassicae*) already mentioned. The Painted Lady butterfly (*Pyrameis cardui*) is a pest of artichokes in France and of various Malvaceous vegetables in North Africa, although mildly beneficial in other countries owing to feeding on thistles. The cutworm, *Agrotis ypsilon*, is a pest of wheat in Egypt and India. The Cotton Leaf-worm (*Alabama argillacea*) is a migrant pest in Central America and the U.S.A. The Silver-Y moth (*Plusia gamma*) is an irregular pest of peas and other field crops in Central and Western Europe. The Hawk Moth *Celerio livornica*, is a pest of vines in Europe and in U.S.A. And there are many others on a long list to which new additions are constantly being made.

Among the harmful insects liable to distribution by air-currents the Aphidae are of major importance, as not only do they directly damage plants by sucking their juices, but they transmit a large range of virus diseases, and in this case a single infected Aphid is enough to start a new disease outbreak. The family Jassidae of the Homoptera also includes a large number of direct pests and some which can transmit virus diseases, such as Beet Yellows in U.S.A. The Jassid which transmits this disease is believed to move also by migration independant of wind direction.

The Colorado beetle (*Leptinotarsa decemlineata*) is known to have been

carried by wind for distances of up to 100 miles or more over the sea, and such occurrences probably account for many of our outbreaks in England, in spite of every precaution taken at the ports. But in this species also there appear to be some flights of a migratory nature in which the direction of movement is not determined by the direction of the wind.

Among beneficial insects distributed by wind are many small parasitic Hymenoptera, Lacewings (Chrysopidae), and some parasitic or predaceous Diptera. When the Aphidae referred to above were found on the snow in Spitzbergen there were also found at the same time Diptera of the family Syrphidae which are predators on Aphidae. At times great swarms of Aphidae appear on our coasts as if they had crossed the sea from the Continent. Sometimes they are washed up dead along the shore line in millions, and in some of these cases both Syrphidae and Coccinellidae are present in large numbers.

Among the beneficial insects known to migrate are Dragonflies (Odonata) – Coccinellidae – Syrphidae and perhaps other Diptera – and at least one species of Sphegidae in the Hymenoptera. Some species of Coccinellidae are known to migrate hundreds of miles to and from their hibernating quarters. Dragonflies are great wanderers in all parts of the world and at least one species (*Pantala flavescens*) has been found hundreds of miles out at sea. Syrphidae have been seen by David LACK to be moving in hundreds of thousands southward in the autumn through passes in the Pyrenees at a height of over 6000 feet (both with and against the wind!). In East Africa I found a burrowing wasp, *Sphex aegyptiacus*, predaceous on the Desert Locust (*Schistocerca gregaria*), which migrated with the swarms of locusts on which it was preying.

So we see that wnile Customs and Quarantine Entomologists may be stationed at intervals along the man-made and often purely artificial frontiers between the nations or states of today – in the air above there may be millions of insects, good or bad, passing by migration or drift from one country to another.

These insects can cross seas a hundred miles or more wide, and mountain ranges 2000 metres or more in height. So that even the normal geographic barriers do not seem to be any protection.

In the past most countries have been much concerned about the insects which they receive from abroad, but little with the insects that go from their country to others. Migrating and drifting insects form the most difficult group of all against which practical action can be taken; and this action has to be international, and not at a purely national level, which unfortunately so often means "one against the other".

In the Locusts a start has been made and there are official International Commissions concerned with the study and control of the Red Locust (*Nomadacris septemfasciata*) in East and South Africa and of the Desert Locust (*Schistocerca gregaria*) in East and North Africa. The South American Locust (*S. paranensis*) has two Commissions, one in Central America, and a second

in the southern half of the South American Continent. But there is as yet no fully International Commission concerned with the migratory locust (*Locusta migratoria*) whose ravages cover about 30 different countries in Africa and Asia.

In the case of the Colorado beetle (*Leptinotarsa decemlineata*), which was introduced into France from N.America towards the end of the first world war, there has been for many years a semi-official organisation in Western Europe for research and control, and it is hoped that a proper International Commission will be established within the next few months.

Entirely new pests do not often enter a country by means of migration and drift, but populations may be reinforced or renewed annually, and there is little doubt that major agricultural losses occur as a result of such movements. A start has been made in international co-operation to cope with such pests, and we all hope that such co-operation will increase in the future. In a world which seems to many of us to be increasingly unfriendly it is pleasant to think that in our field of Entomology there is already so much readiness to co-operate for mutual benefit.

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SECTION I

SYSTEMATICS AND MORPHOLOGY

LES ORGANES TYMPANIQUES DES LEPIDOPTERES COMME CARACTERE SYSTEMATIQUE ET PHYLOGENETIQUE

par

S. G. KIRIAKOFF

Gand, Belgique

Au cours d'un des symposiums auxquels nous avons assisté ici, il a été arlé de l'importance des organes génitaux pour la taxonomie des Insectes. e voudrais attirer ici l'attention de mes collègues sur un autre organe, noamment sur l'organe tympanique dont sont munis certains groupes d'insectes épidoptères. L'emploi qu'on en a fait jusqu'ici en systématique et surtout n phylogénie est nettement insuffisant, si l'on tient compte de sa valeur xceptionnelle.

Alors que les organes génitaux constituent un excellent caractère permetant la différenciation spécifique, subgénérique et même générique – il ne me emble pas qu'on puisse raisonnablement aller au-delà – les organes tympaiques, eux, se prêtent en premier lieu à la différenciation des catégories axonomiques supérieures: sous-familles, familles, super-familles, et même lus haut. Cela n'exclut pas leur emploi comme caractère différenciant les nités taxonomiques inférieures, jusqu'à l'échelon spécifique.

Le temps limité mis à ma disposition ne me permet que d'essayer de broser une esquisse générale de la valeur des organes tympaniques comme aractère differenciel, et de l'illustrer par quelques exemples empruntés à es propres recherches.

Les grandes divisions des différents types d'organes tympaniques sont éjà très généralement connues, et même partiellement utilisées dans la lassification. C'est ainsi qu'on reconnaît généralement l'existence de pluieurs groupements taxonomiques caractérisés par la présence d'organes tymaniques abdominaux, et la valeur superfamiliale a déjà été attribuée par uelques auteurs à des complexes comme les Geometroidea, les Uranioidea, s Pyraloidea; la proche parenté des familles Thyatiridae et Drepanidae ne ait plus de doute. Il ne semble pas que l'établissement éventuel d'une supermille Axiadea, caractérisée par la présence d'organes tympaniques placés ur le 7e segment abdominal et découverts par l'éminent Prof. FORBES, doive ncontrer beaucoup d'objections.

Quant aux formes possédant des organes tympaniques du type thoracique, crois avoir démontré par une série de travaux, en grande partie déjà puliés, qu'il est nécessaire d'admettre l'existence de deux structures voisies, mais différentes et évoluant chacune dans une direction propre. J'ai donc roposé la création de deux superfamilles Notodontoidea et Phalaenoidea. a raison décisive m'ayant conduit à proposer cet arrangement a été la conatation de l'identité pratique des organes tympaniques trouvés chez les otodontidae et chez les Dioptidae avec ceux présentés par un petit groupe

africain, rattaché généralement aux Ctenuchidae, et dont j'ai fait la famille Thyretidae. Cette famille, possédant un ensemble de caractères très évolués, se place à la tête de la série Notodontoïde et correspond à la famille Ctenuchidae, groupe le plus évolué et occupant une place à la tête de l'autre série, les Phalaenoidea.

L'existence de deux superfamilles à organes tympaniques thoraciques nous permet de faire une constatation très intéressante se rapportant au domaine de la phylogénie. Au cours de leur évolution, ces deux séries phylétiques s'écartent par la structure de leurs organes tympaniques qui se spécialisent dans une direction propre à chacun de ces groupes; mais ils se rapprochent, dans leurs formes les plus évoluées (Thyretidae et Ctenuchidae respectivement), par leurs caractères de vénation. Ces deux tendances, une divergente, l'autre convergente, et ce neutralisant en quelque sorte, conditionnent ce que j'appellerai une évolution parallèle des séries phylétiques. Si nous appliquons à ce cas la règle de déviation définié par le Dr. HENNIG dans son récent et magnifique ouvrage „Grundzüge einer Theorie der phylogenetischen Systematik", nous voyons qu'une série de caractères apomorphes, c'est à dire s'écartant des caractères ancestraux, ce réproduisant dans les branches évolutives successives, peut dans certains cas donner l'impression d'un rapprochement entre ces branches, quand ces caractères apomorphes sont les mêmes. Dans notre cas particulier, il ne s'agit pas d'une simple convergence, car la simplification de la vénation paraît être une loi générale chez les Lépidoptères; certains parleraient ici d'orthogenèse. Je préfère employer le terme de SIMPSON: évolution rectilinéaire.

Si nous évaluons l'importance intrinsique des organes tympaniques comme caractère différentiel, nous sommes bien obligés de lui accorder une place préponderante. Un organe de cette compléxité, nécessitant le développement d'un nerf spécial, le scolopaire, et une modification profonde de la région intéressée, abdominale ou thoracique, ou des deux à la fois, — et présent seulement dans certains des groupes reconnus comme spécialisés, — ne peut raisonnablement qu'obtenir la préséance, comparé à la plupart d'autres caractères morphologiques, surtout exomorphologiques, utilisés pour la classification des Lépidoptères, comme la vénation, la trompe, les palpes, les éperons etc.

En prenant les organes tympaniques comme organe différentiel de valeur primordiale, nous nous conformons à la règle qui veut que plus un caractère est compliqué, plus il est important. Le principe de WARREN des caractères diagnostiques véritables trouve ici une application mettant particulièrement bien en valeur son bien-fondé. La compléxité des organes tympaniques nous permet, enfin, d'en utiliser les diverses composantes structurelles: le phragme scutal, le cadre, le nodule, le contre-tympan, comme autant de caractères servant de base à l'établissement de coupes secondaires, dans les grandes divisions que nous sommes amenés à reconnaître.

Je parle ici surtout d'organes tympaniques du type thoracique, mieux étudiés dans leurs détails et qui font l'objet de mes recherches depuis plusieurs

années. Une étude approfondie des organes tympaniques abdominaux permettra sans doute leur utilisation plus poussée dans la classification des groupes caractérisés par leur présence.

Quelques exemples, tirés de mes recherches déjà publiées, en cours de publication ou en préparation, illustreront les possibilités d'utilisation des organes tympaniques thoraciques dans la classification et la phylogénie.

1. La famille des Ctenuchidae est indubitablement d'origine américaine, plus exactement néotropicale, car les formes à organes tympaniques rudimentaires (sous-famille Amatinae), répandues uniquement dans l'ancien monde, doivent être considérés d'origine plus récente, et présentent une réduction secondaire d'organes tympaniques: c'est un cas d'apomorphose extrêmement interessant. Parmi les formes à organes tympaniques bien développés (sous-famille Ctenuchinae), une série de genres est caractérisée par la présence d'une bulle pleurale au premier segment abdominal, servant probablement d'amplificateur des sons. La même bulle, quoique moins bien développée, se retrouve dans l'unique genre paléotropical de cette sous-famille, le genre *Euchromia*. Nous pouvons en conclure que l'origine de la dite bulle est antérieure à la séparation définitive des continents sud-américain et afro-indien; les Ctenuchinae qui la possèdent (et ce sont les genres les plus spécialisés) doivent donc dater au moins de l'éocène moyen. Toutes ces considérations nous conduisent à la necessité de réexaminer les rapports phylogénétiques entre les deux sous-familles en question et à nous demander si l'éminent Dr. BÖRNER n'avait pas raison en réunissant les Ctenuchidae aux Arctiidae, en conservant le nom de „Syntomidae" (recte Amatidae) et le rang de famille aux seules formes à organes tympaniques rudimentaires.

2. La famille des Thyretidae, déjà citée, a été rangée jusqu'ici parmi les Ctenuchidae à cause de sa vénation; bien qu'elle s'en distingue par quelques autres caractères exomorphologiques – pièces buccales, éperons – les classifications modernes n'en font même pas une sous-famille ou une tribu au sein des Ctenuchidae. Par la structure de leurs organes tympaniques – du type dit „à timbale" – les Thyretidae s'écartent, cependant, totalement des Ctenuchidae et se placent à côté des Notodontidae, auxquels ils doivent donc être associés dans un groupement superfamilial (la superfamille Notodontoidea). Leur vénation évoluée et leur localisation géographique – continent africain, Madagascar – permettent de supposer qu'il s'agit d'un groupe relativement récent, postérieur a l'éocène, s'étant différencié des Notodontidae avec lesquels les Thyretidae ont un ancêtre commun. Il s'agit ici encore d'un exemple de la règle de déviation de HENNIG, règle qui, dans mon opinion, régit la grosse majorité, sinon la totalité, des cas de divisions phylétiques.

3. L'étude de la structure des organes tympaniques de la superfamille des Notodontoidea m'a permis d'émettre l'hypothèse de l'origine non nordique, mais néotropicale de la famille Notodontidae. Cette hypothèse explique en même temps l'origine des Thyretidae et place celle-ci à une époque postérieure à la séparation définitive des continents sud-américain et afro-indien. Un autre exemple se place dans le cadre des mêmes considérations. J'ai dé-

crit, au sein des Notodontidae, une sous-famille Tarsolepidinae, caractérisée par un phragme scutal d'un type aberrant, différant complètement du phragme scutal dit notodontoïde, observé chez la grosse majorité des f..mes appartenant à la superfamille Notodontoidea. Le petit groupe des Tarsolepidinae est aussi localisé en Asie sud-orientale, atteignant au nord la région paléarctique (Japon, Chine); ce fait nous permet de le considérer comme étant d'origine plus récente; c'est encore un groupe apomorphe, pour employer le terme de HENNIG.

4. Un autre exemple d'apomorphose nous est fourni par la nouvelle sous-famille Rhodogastriinae. Le groupe de *Rhodogastria* a été souvent considéré comme remplaçant dans l'ancien monde les Phaegopterinae américains. Il possède cependant, suivant mes recherches, des organes tympaniques d'un type s'écartant considérablement du type commun phalénoïde, et se rapprochant à première vue davantage du type notodontoïde dit à timbale, quoiqu'en réalité il s'agisse d'une convergence causée par une ressemblance superficielle. Or, ce même type particulier se retrouve chez un petit nombre de Phaegopterinae (*Pelochyta*), la grande majorité de ces derniers se distinguant des Arctiinae (= Spilosominae de CHIN-JEN LUH) surtout par les particularités du contre-tympan et en général par des détails secondaires. Les *Rhodogastria* assurent donc la vicariance dans l'ancien monde non avec les Phaegopterinae, mais avec les *Pelochyta* et genres voisins encore mal connus, et nous pouvons accorder à ce groupe le rang sous-familial; son origine devra être cherchée à une époque antérieure à la séparation des continents américain et afro-indien.

5. Citons encore un cas d'apomorphose matérialisée apparemment très tôt, qui peut être constaté dans la famille Lithosiidae. Ici, un groupe nombreux de genres a développé des organes tympaniques d'un type particulier, à cadre complètement fermé et à membrane tympanique verticale. C'est ma sous-famille Endrosinae (travail qui paraîtra dans le „Biologisch Jaarboek" pour 1951). L'ensemble des caractères de ce groupe laisse supposer que celui-ci est plutôt généralisé; ses organes tympaniques montrent, cependant, une spécialisation qui nous mène à la supposition, pouvant être étayée par d'autres exemples, que dans beaucoup de cas, la déviation est dûe a la tachytélie de SIMPSON ou évolution à cadense accélérée. Cette tachytélie peut être — et est souvent — temporaire.

L'autre sous-famille, les Lithosiinae, est moins homogène, montrant une évolution des organes tympaniques allant d'un type caractérisé par l'absence de nodule à un type se rapprochant beaucoup de celui rencontré chez les Arctiidae. Les recherches ultérieures devront montrer si les Lithosiinae doivent être réunis à ces derniers, les Endrosinae en restant en tous cas séparés.

6. L'étude des organes tympaniques peut apporter des changements importants non seulement dans la classification des groupes hiérarchiques supérieurs, mais même dans celle des genres et espèces. Un exemple nous suffira ici pour illustrer ce fait. Les espèces africaines du genre *Eressa* (Ctenuchidae) ont été isolées par BETHUNE-BAKER dans le genre *Eressades* à cause

de quelques caractères paraissant secondaires (trompe et palpes absents, antennes du mâle à pectinations longues, veine 4 des ailes postérieures présente); cette séparation n'a pas été généralement acceptée en raison du peu d'importance de ces caractères. Or, l'étude des organes tympaniques de diverses espèces du genre *Eressa* a montré que si les espèces orientales appartiennent en réalité aux Ctenuchidae, sous-famille Amatinae, à organes tympaniques rudimentaires, les espèces africaines possèdent des organes tympaniques du type dit „à timbale" ou notodontoïde, et doivent donc être rangées non seulement dans une autre famille (Thyretidae), mais même dans une autre superfamille (Notodontoidea). Les caractères sur lesquels a été fondé le genre *Eressades* confirment d'ailleurs ce changement de place, correspondant aux caractères trouvés chez les Thyretidae.

Le jour où plusieurs spécialistes s'occuperont activement de l'étude des organes tympaniques de la majorité, voire de la totalité des formes tympanophores, des cas comme ceux cités dans cet exposé se multiplieront certainement. Il est d'ores et déjà certain que les organes tympaniques peuvent servir de caractère differenciel sur le plan générique et spécifique, comme l'a prouvé GLENN RICHARDS dans son étude des *Phoberia*, *Melipota* et genres alliés (Erebinae, Noctuidae). Quant aux arrangements d'ordre supergénérique, l'utilisation des organes tympaniques a déjà rendu et rendra encore des services jamais surpassés par l'emploi d'un autre caractère morphologique.

THE TAXONOMIC POSITION OF THE HESPERIIDAE AS DERIVED FROM THE MORPHOLOGY OF THE COMPOUND EYE

by

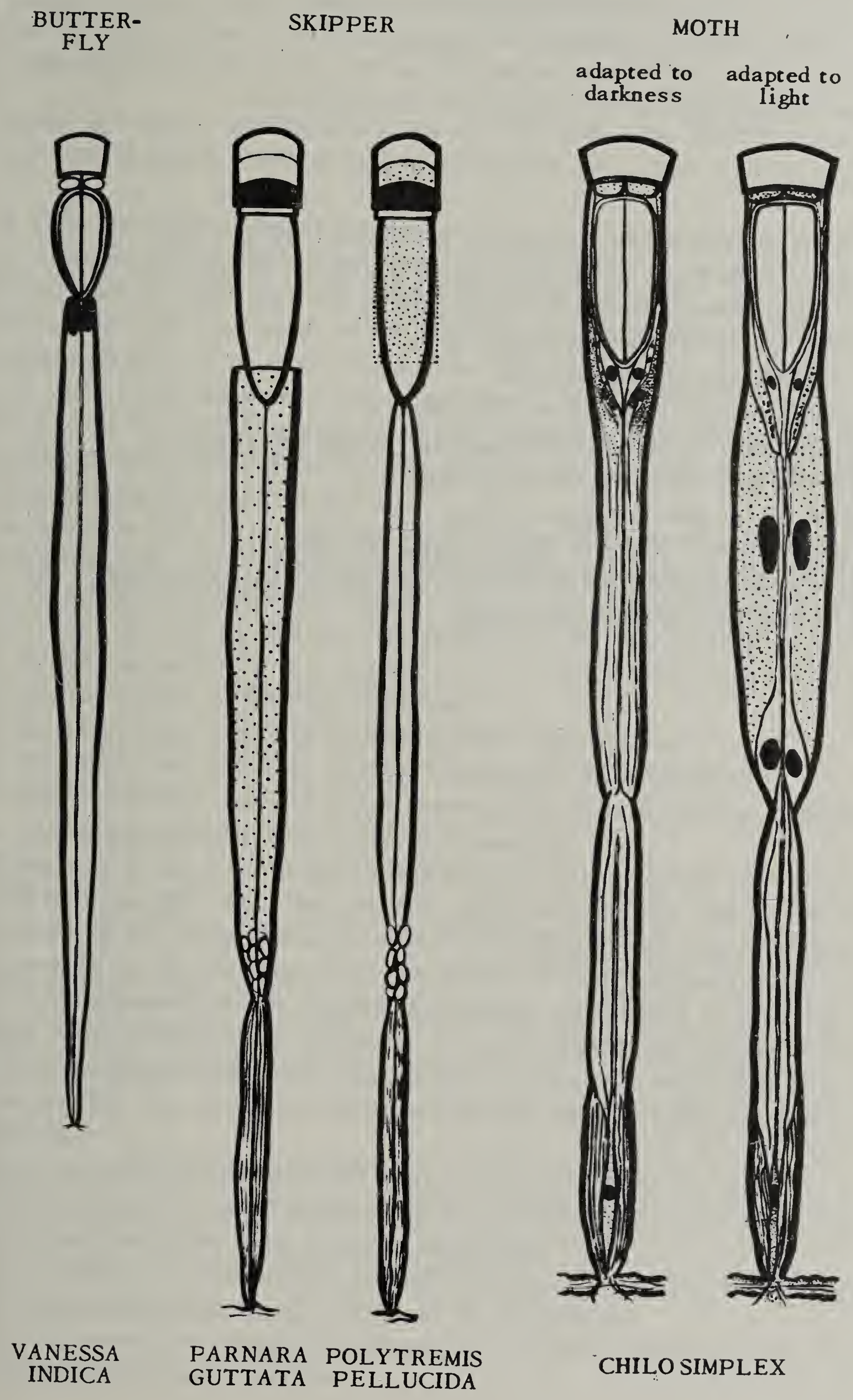
N. YAGI

Shinshu, Japan

In the classification of the order Lepidoptera to the family Hesperiidae still widely different positions are assigned according to the views of the various entomologists. REUTER (1896) and SEITZ (1909) have referred it to a special subdivision "Grypocera" in contradistinction to the other butterflies. HEYMONS (1915) united it with the more primitive groups in the tribe "Microfrenatae" which is called Stemmatocopoda by KARSCH (1915). Others, such as TURNER and TILLYARD (1926), and IMMS (1934) treated it as a family of the butterflies (Papilionoidea). HANDLIRSCH (1926), on the other hand, placed it in a superfamily Hesperioidea near to Rhopalocera pointing out the distant relationship between these two groups.

MEYRIK (1928) was of the same opinion, referring Hesperiidae to the phylum "Hesperiana" near the true butterflies (Papilionina). Quite recently S.G.KIRIAKOFF, in Belgium, placed Hesperiidae in the superfamily Hesperioidea together with the moth families Thyrididae and Pterophoridae because of the special characters of the larval prolegs which are of the Stemmatocopodous type, the reduced ocelli, the absence of tympanal organs, and the piriferous pupae.

I studied dissections of compound eye and have found that every species of Hesperiidae showed the distinct type of a superposition eye – very similar to that of the diurnal active moth in Sphingidae. The external shape of the butterfly eye is elliptic or ovoid, but that of the skippers is conical like the eye of the moths. The colour of the Hesperiid eye is seen as dark, being affected by the brown colour of the boundaries of the corneal lens which permit the light to enter straight down from the surface of the lens, and therefore the pseudopupil cannot be seen, as is the case in a butterfly eye. The lens is extraordinarily convex, much as in the eye of the moths. The crystalline cone is three and a half times as long as broad, the same as in the eye of moths. There are two types of ommatidia around the crystalline cone. In the first type the majority of the cone, except its proximal part, is encircled by the fixed pigment cells which contain fewer granules. The retinular cells extending from the bottom of the cone are transparent, without granules, and at the proximal end seven or eight nuclei of the retinular cells are assembled just above the tracheal tapetum; this is similar to the moth eye. The second type of ommatidium has no pigment cells surrounding the cone; the end of the cone is covered by the slightly pigmented upper portion of the retinular cells – unlike the cone of the first type. The compound eye of a species of Thyrididae showed a different type, with deeply pigmented cells surrounding the crystalline cone, as in the case of the ommatidium of the eyes of nocturnal moths,


BUTTER-
FLY
SKIPPER
MOTH
adapted to
darkness
adapted to
light
VANESSA
INDICA
PARNARA
GUTTATA
POLYTREMIS
PELLUCIDA
CHILO SIMPLEX

adapted to darkness. The lens in this family is very similar to that of the eye of Hesperiidae, but is not partially coloured as in a Hesperiid. A roundish pseudopupil can be seen, as in the case of the moth eye.

The author agrees with KIRIAKOFF in maintaining that Hesperiidae should be separated from the butterflies, but he does not think that they should be placed along with Thyrididae and Pterophoridae in Heterocera. He thinks that Hesperiidae should rank as an independent group near to Heterocera and far from Rhopalocera, as is accepted by HANDLIRSCH.

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SOME SPECIAL DETAILS ABOUT VERY RARE OR LITTLE KNOWN LEPIDOPTERA SPECIES, INCLUDING THE DEMONSTRATION OF THESE

by
G.A. COUNT BENTINCK
Amerongen, Holland

I. SOME REMARKS CONCERNING THE DUTCH AND THE EXTINCT BRITISH FORMS OF *HEODES (CHRYSOPHANUS) DISPAR* HW., THE LARGE COPPER

In 1915 The Large Copper was newly discovered in Holland, in the province of Friesland, after the last recorded specimens, five in number, were taken in Holme Fen in 1848, when the British race of *C. dispar* became extinct.

Soon after this remarkable event this new discovered race (?) was subsequently referred to by N.D.RILEY (The Entomogolist 53: 10, 1920), and a list of some of its distinctive characters was given, and later on it was fully discussed by Dr J.TH.OUDEMANS in the Tijdschrift voor Entomologie, Vol. 65: 197-211, 1922, and figured on pls. 5 and 6, for these to be compared with the British race (?) on pls. 3 and 4.

On principle OUDEMANS did not wish to give this Dutch race a new name; and this was left for OBERTHÜR to do in Etudes Lép. Comp. 21: 73, pl. 570: 4914-4915 (1923), where it was described as *Chr. dispar batavus* to distinguish it from the extinct British *Chr. dispar dispar.* OUDEMANS' reason was that he did not consider it a separate race at all. In his above mentioned paper he quotes the 3 following questions:

1. Is the Dutch form identical with the extinct British form?
2. Is the Dutch form identical with the Continental form *(rutilus)*?
3. Is the Dutch form a missing link between the British and the Continental form, and which of these does it approach mostly?

These questions were largely discussed by RILEY (cited above) and by OBERTHÜR in Bull. Soc. ent. France 1920, no.5, p.254; and in the same, 1921, no.1, p.15, in which RILEY and OBERTHÜR do not agree at all about the question of two different races or forms. In this quotation OBERTHÜR says: "Dernièrement le *Chr. dispar,* absolument conforme à la race anglaise éteinte, a été découvert en Hollande. J'ai pu comparer un superbe ♂ hollandais aux anciens échantillons anglais que renferme ma collection. Il me paraît impossible de constater aucune différence entre les *dispars* hollandais et anglais."

Later on OBERTHÜR obtained more Dutch specimens and in his second quotation he says: "Les 2 sexes de la race néerlandaise sont bien semblables à la race anglaise éteinte depuis longtemps."

RILEY quotes in his article six differences. OUDEMANS refers to these in his above mentioned article. They are the following:

1. In both sexes the marginal red band on the hind wing underside is consistently narrower than in *dispar.*

2. The black spots on the underside, especially of the hind wing, are consistently smaller than in *dispar.*
3. In the ♂ the black marks in all, and at cell end on the upperside of the fore wing are always smaller than in *dispar.*
4. The hind margins of fore wings below in both sexes are invariably greyer than in *dispar* in which they are brownish.
5. The tendency in the ♀ for the black spots in the band on the upperside of the forewing to be produced towards the base of the wing in long rays is more pronounced in the Dutch specimens than in *dispar.*
6. The ground colour of fore wings below in both sexes is slightly paler than in *dispar.*

OUDEMANS refutes these six points, as RILEY only had seven Dutch specimens to compare with 99 British ones, whereas OUDEMANS had 180 Dutch specimens and the same 99 British ones, by which he comes to other conclusions.

Take e,g. the second case (the black spots on the underside), referring to OUDEMANS' article mentioned above: you will notice that the British ♂, fig. 16, has the largest spots on the underside of the fore wings, larger than any Dutch specimens. Compare too the other ones: 13, 14, 15, 17 and 18 with the small Dutch one no. 35 which specimen I demonstrate specially from my own collection, being the one with the next largest spots on the fore wings. The general conclusion is that *Chr. dispar batavus* is practically the same as *Chr. dispar dispar,* and inclines very slightly towards *Chr. dispar rutilus,* with one exception that *batavus* has normally a much darker hind wing in the ♀ than *dispar,* so that in this case *dispar* stands between *batavus* and *rutilus.*

The Report of the Committee appointed by the Entom. Soc. of London for the Protection of the Brit. Lepid., 1929, brings some more differences. But these too can be refuted, as individual examples occur in each form that can be readily matched with examples in the other.

The only reason OBERTHÜR gave for the erection of the name *Chr. dispar batavus* is this: "En résumé les *Chr.* hollandais appartiennent bien à la magnifique race *Dispar.* Mais il conviendra sans doute de les distinguer par un nom qui indiquera leur provenance."

So one cannot call *batavus* a race of *dispar,* which *rutilus* undoubtedly is. The best solution for a right nomenclature is the one B.J.LEMPKE proposes in the Entomologische Berichten 9, no.208, p.219 (also not quite according to the rules of nomenclature):

1. *Heodes dispar dispar* Hw. Britain.
2. " *dispar dispar batavus* Obth. Netherlands.
3. " *dispar dispar* .... St.Quentin (extinct).
4. " *dispar rutilus rutilus* Werneburg. Central Europe.
5. " *dispar rutilus burdigalensis* Lucas. Bordeaux.

II. SOME DETAILS ABOUT THE FOLLOWING SPECIES, INCLUDING THEIR DEMONSTRATION

1. *Pelosia obtusa* H.S. Very little is known about this Lithoside species from the peatmarshes. Mr. DOETS and myself captured quite a number in the Kortenhoef marshes near Hilversum. Tijdschr.v.Entom. 83: XIX; id., 90: 11; id., 91: XIX.
2. *Whittleia (Epichnopteryx) retiella* Newn. Some ♂ and ♀ specimens captured near Amsterdam and Hilversum, extremely local. Tijdschr.v.Entom. 67: LXXII; id., 68: LXXIV; id., 73: XCIV; id., 79: LXXVII.
3. *Bankesia staintoni* Wlsghm. Some ♂ and ♀ specimens captured by the late Dr LYCKLAMA À NIJEHOLT near Nijmegen. Tijdschr.v.Entom. 72: XC.
4. *Chilo cicatricellus* Hb. Some specimens captured by Mr. DOETS and myself in the Kortenhoef marshes. Tijdschr.v.Entom. 90: 11; id. 91: XIX; Entom. Berichten no.292: 413.
5. *Homoeosoma pseudonimbella* Bntk. Not very local. Tijdschr.v.Entom. 80: 73; The Entomol. 70: 101, pl.3; Lambill. 1936: 250; Veröff. Deutsch. Kol. & Uebers. Mus. 2: 176.
6. *Tortrix neglectana* H.S. (nec *Cacoecia* as the costal fold is wanting). DOETS captured three specimens of this very local and little known species which resembles *Cac. unifasciana* Dup. very much.
7. *Pammene snellenana* Bntk. As far as is known only three specimens have ever been captured till now. Tijdschr.v.Entom. 88: 155.
8. *Plutella megapterella* Bntk. Quite a few specimens have been captured till now, especially in Palestine. Tijdschr.v.Entom. 77: 175.
9. *Atremea lonchoptera* Staud. Quite a few specimens were captured by DOETS and myself in the Kortenhoef marshes. Before this locality was discovered, only six specimens, all males, were known of this very rare species. Lambill. 1940: 32; Tijdschr.v.Entom. 83: XIX; id., 90: 111; id., 91: XIX; Entomol. Ber. no.292: 416.
10. *Chrysoclista lathamella* Fletch. (= *bimaculella* Hw.). One very odd ♀, quite different to any other *lathamella* specimens, is the only one ever captured in Holland. The late Mr PIERCE examined the genitalia and found these identical with *lathamella*, although he said it might quite as well be an unknown species. Tijdschr.v.Entom. 69: XXVII, 203 & 214.
11. *Zimmermannia heringiella* Doets, bread by DOETS who discovered the mines in the still smooth bark of branches of oak shrubs. Tijdschr.v.Entom. 88: 504.
12. *Tinea piercella* Bntk. Till now only one specimen has ever been captured of this rare species. Tijdschr.v.Entom. 79: 238.
13. *Crambus paludellus* Hb. ab. *griseastrigata* Doets. This strange looking specimen with broad darkened margins almost all round the wings, was captured by DOETS in the Kortenhoef marshes.

DISCUSSION

Mr. **Hackman:** pointes out that *Pammene snellenana* Bentinck is very similar in habitus to *P. luedersiana* Sorh. and that a comparison of the genitala of these two species could be of interest.

Mr. **Hering:** Es ist sehr sonderbar, dass die holländische Subspecies von *dispar* so verschieden ist von der britischen. Central-asiatische Stücke sehen oft den britischen ähnlicher als die holländischen.

Zimmermannia ist vielleicht dieselbe Gattung wie die nearktische *Ectoedemia.* Ausser den zwei bekannten Arten (an Fagus und Quercus) existiert eine dritte Art, die in der Rinde von Castanea im Süden miniert, deren Zucht den Entomologen im Süden empfohlen wird.

Mr. **Stempffer:** Gives some information about the actual distribution of *H. dispar rutilus* in France.

Mr. **Wiltshire:** Gives information about Norfolk colony of *dispar batavus.*

Mr. **Riley:** Refers to the status of *Lycaena dispar batavus* in England.

THE RELATIONS BETWEEN PIERIS NAPI L. AND PIERIS BRYONIAE OCHS.

by
Björn PETERSEN
Uppsala, Sweden

In the species *Pieris napi* L. a very strong geographic variation exists which is especially marked in the females. In the Scandinavian mountains these are yellow on the upper side with broad dark markings (ssp. *adalwinda* Fruhst.) while the females of southern Scandinavia are white with thin markings (ssp. *napi*). A smooth cline is present in the intermediate area which is only a little steeper on the border between the mountains and the lowland.

In the Alps a form exists which is rather similar to the Scandinavian mountain form. This form has already for many years been looked upon as a separate species, *Pieris bryoniae*.

During the summer of 1951 the two species were studied in the Ostrach valley in the Allgäuer Alps. The bottom of the valley is situated at 700 – 900 m above sea level while the surrounding mountains reach 1600 – 1900 m. Collections were made here from the 23rd of May to the 14th of June and from the 30th of June to the 25th of July. All specimens found are definitely *napi* or *bryoniae*, as is shown for the females in fig. 1. One specimen which is somewhat intermediate was found together with *P. bryoniae* and probably belongs to that species, though it is of course not impossible that it is a hybrid.

As the two forms are easily crossed in cages for several generations it is obvious that in nature some isolating factors are present. Isolation in space and time is certainly of importance. In order to study this, specimens were collected at different levels during the whole time of the investigation.

The winter of 1950- 1951 was rich in snow and the spring came extremely late. The dates presented here will therefore be one, two or even three weeks later than usual, but in principle I do not think that it makes any great difference.

The first specimen of *P. napi* was seen on the 17th of May. The first generation was on wings until the 19th of July, thus during more than two months. During the earlier part of this time the species was found only below 1150 m, in July, however, up to 1763 m.

This late appearance of the first generation is probably due to the snow cover which was especially thick in the deep canyons where many of the butterflies are to be found. It may be noted that specimens looking like the first generation and taken in July are present here and there in the collections but almost no one has dared to place them in their right generation.

Two females of the second generation were found during my absence by Mr. SCHWARZBECK already on the 23rd of June. This generation however

Yellow colour \ Dark markings	1	2	3	4	5	6	7	8	9
1	4	11	7						
2		3	1					1	
3				1		1	3	11	1
4						2	16	24	5
5						2	10	25	2
6						1	1	2	

P. napi *P. bryoniae*

Fig. 1. Distribution of females of *P. napi* (1st generation) and *P. bryoniae* from the Ostrach valley according to ground colour of the upper side of the hind wings (1 = white, 6 = saturated yellow) and breadth of dark markings on the upper side of the wings (1 = very thin markings, 9 = dark markings covering the whole upper surface).

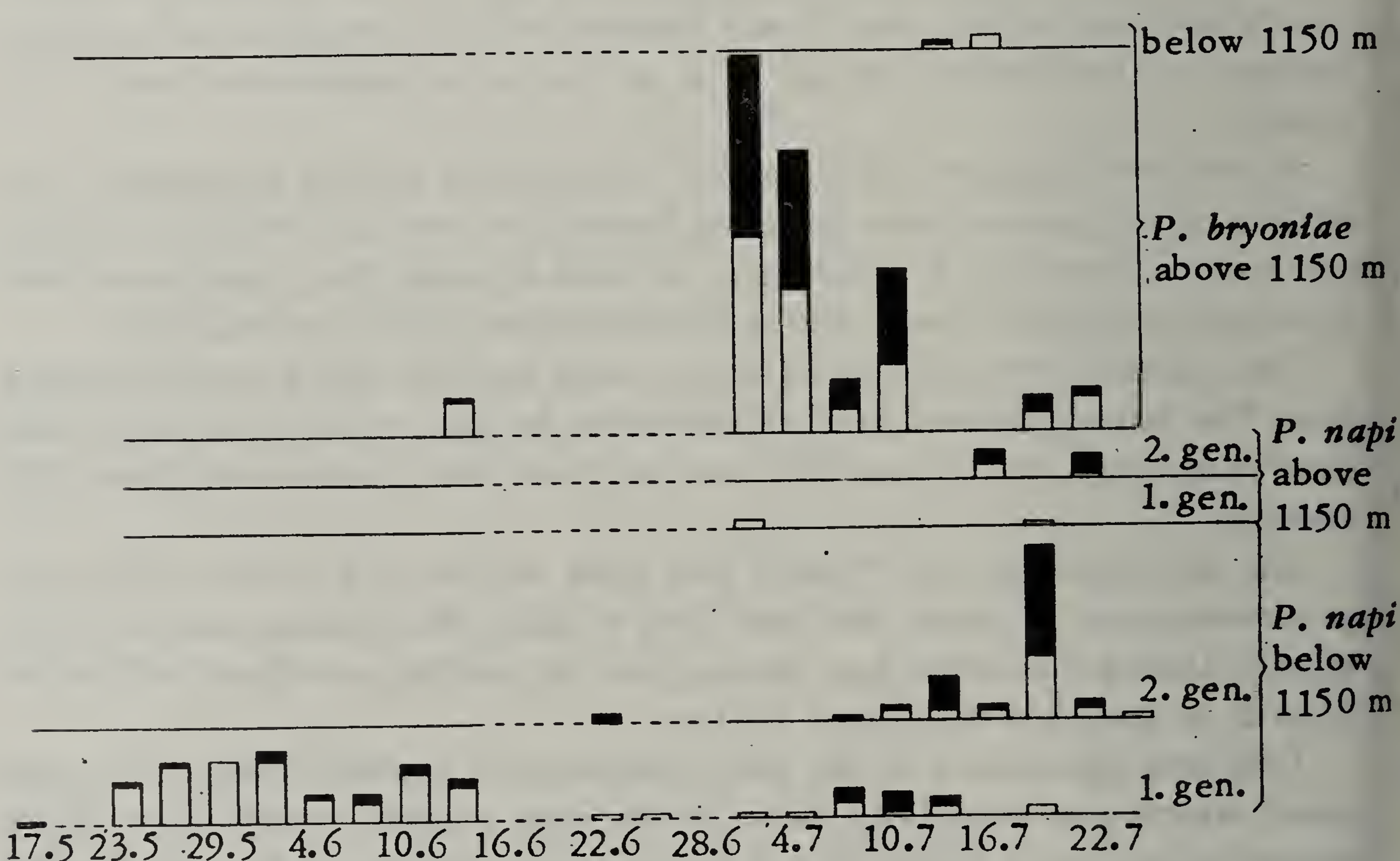

Fig. 2. Catches of *P. napi* and *P. bryoniae* below and above 1150 m in the Ostrach valley during the summer 1951. Abscissa = time, ordinate = number of specimens. White areas indicate males, black areas females. No catches were made by the author from the 15th to the 30th of June. A few catches made during this time by Mr. and Mrs. SCHWARZBECK are shown on the diagram.

did not become common before the middle of July and reached its maximum first in August. During the latter part of July the second generation also appeared in the higher parts of the mountains, also the females. Their descendants, the first generation of the next year, will hardly occur on these higher levels, as they did not this year. The probable reason is that there is no time for the larvae to reach the pupal stage before winter, and hibernation is only possible in this stage.

P. bryoniae was found in a few specimens on the Iseler on the 14th of June at 1350-1550 m. When the next visit was made at the beginning of July both males and females were common at 1500-1600 m. Seven pairs in copula were seen during the 2nd and 3rd of July and two as late as the 10th. At this latter date *bryoniae*, however, was common at slightly higher levels from 1600 m to 1700 m. On the 18th and 21st of July only a few rather worn specimens were seen.

During the latter part of its flying time *P. bryoniae* also appeared in the valley at 800-900 m. Here four males and one female were found in different places. On the spot where the female was taken another female was found last year by Mr. SCHWARZBECK. Thus, a small colony of *P. bryoniae* is possibly present there in the valley near Imberg. The four males can hardly come from this colony as they were scattered over many kilometres.

Before we discuss the influence on isolation of these data it may be mentioned that the females hardly are able to fly very far before the copula. Mating females found in nature are almost always very fresh, sometimes still with weak wings.

With regard to the possibilities of isolation we may conclude 1) that there are no or almost no *bryoniae* males at lower levels when the 1st generation of *napi* emerges, 2) that very few *napi* males of the first generation occur at higher levels when the *bryoniae* females appear, 3) that a few *bryoniae* males and females occur at lower levels together with the second generation of *P. napi*. Thus in an area like the Ostrach valley a rather strong isolation in space and time is present.

In other areas of the Allgäuer Alps the two species occur together as e.g. in the Rappenalp valley. This valley that is situated at 1000-1200 m was visited only twice on the 6th and 8th of July. A few observations of interest were, however, made. All specimens taken are as distinctly *P. napi* or *bryoniae* as the specimens from the Ostrach valley. The females of *napi* seem on an average to be a little yellower on the upper side but this may be just by chance due to the small number of specimens caught.

Another fact is that *P. bryoniae* flies later in the Rappenalp valley at 1000-1200 m than on the Iseler at 1500-1700 m. In the Rappenalp valley only a few females had begun to fly on the 6th of July while the males were common. The females of the Iseler, on the other hand, were common already on the first of July. This might be an adaptation to avoid the flying time of *P. napi* of the same area. A comparative study of the flying time of *P. napi*

and *bryoniae* from several sympatric and allopatric areas might solve this problem.

As in a sympatric area many males of *P. napi* are on wings when the females of *P. bryoniae* emerge, it is obvious that also other isolating factors are at work. In 1950 it was found that white, dried specimens of *P. napi* are attacked if they in nature are exposed to males of *P. napi napi*. Yellow females on the other hand were only rarely attacked. No influence of the extent of the dark markings on the attacks of the males was obtained.

The case seemed clear. Males of *P. napi* with white females attack white specimens while the males of *P. bryoniae* with their dark yellow females attack females of that colour. In reality it is, however, otherwise. The males of *P. bryoniae* are heavily attracted by the dried females of *P. napi* and prefer them to their own yellow and dark ones, when they are in a dried condition. In nature a male of *P. bryoniae* more often attacks another male, which is white, than a female.

It is possible that only the addition of the movements of the female wings are necessary to release the attraction of the males of *bryoniae*. This is suggested by an attack of such a male on a flying *Hesperia* sp.

The isolating factors mentioned up to now would result in a more effective prevention of the cross *napi* male × *bryoniae* female than the reciprocal one.

Different odours are, however, also at work. The males of *P. napi* and *P. bryoniae* have very strong odours similar to that of citrus skins. I was not able to find any difference in that odour in *P. napi* and *P. bryoniae*. In the females, on the other hand, a difference is quite distinguishable to the human sense of smell. Both smell like freshly cut hay, but the smell of *bryoniae* is much stronger and also different.

In the *Pieris napi* group we find speciation in progress. In some areas as e.g. in Scandinavia the forms mate rather at random, in the Alps they form two different species. We have a somewhat similar case to that of *Passer domesticus* and *P. hispaniolensis* which in some areas live without mixing while they in others hybridize. It is interesting to note that in the *napi* group there is also an overlap between a northern and a southern form in the Amur area as in *Parus major*. It seems therefore to be rather a type example showing speciation at work in the northern hemisphere.

If we use the common nomenclature *Pieris bryoniae, P. napi napi* and *P. n. adalwinda* this is in full agreement with the biological species concept but contradictory to the most probable phylogenetic relationships. It is probable that *P. n. adalwinda** is more closely related to *P. bryoniae* than to *P. napi*, and it is at least phenotypically more similar to the first mentioned form. The biological species concept will probably in many cases fail to agree with the typological and perhaps also the phylogenetical one.

DISCUSSION

Mr. **Williams**: asks if Mr. PETERSEN had noticed a difference in habit of pupating between *napi* and *bryoniae*.

Mr. **Petersen**: I have reared *P. napi* and *P. bryoniae* this summer but have not noticed any differences in the habit of pupating of the two species.

Mr. **Roepke**: Are the food plants of your *napi* and *bryoniae* the same?

Mr. **Petersen**: No, they are quite different. *P. bryoniae* has a preference for Biscutella, whereas *napi* feeds on a number of Cruciferous plants.

Mr. **Hasselbarth**: Welche Stellung haben *bryoniae flavescens* und *neobryoniae* im Bezug auf *bryoniae bryoniae* und *napi*?

Mr. **Lorkovic** answers: diese Arten sind im Begriff sich zu bilden. Daher sind die einzelnen *bryoniae*-Formen alle verschiedene Übergangsstadien.

THE EVOLUTION OF ANTIGENY IN THE COLOR-PATTERN OF SOME SCOLIIDAE

by

J. Chester BRADLEY
Ithaca, U.S.A.

The primitive coloration within the family Scoliidae is found in some of its most primitive species, as, for example, *Campsoscolia octomaculata hermione* (Banks). In this subspecies the ground color is black, the pronotum, scutellum, metanotum and the apices of the abdominal terga narrowly banded with pale yellow. The female, as is usual in Scoliidae, is a stockier insect than the male, with larger head, shorter, more curled antennae, bulkier thorax, shorter fossorial legs, and stouter abdomen. But in color, apart from some additional spotting of the female on head and propodeum, there is very little sexual difference. The tergal bands are a trifle wider in the female, and show a little more tendency to interruption.

From this starting point evolution of the color-pattern has followed two main directions in repeated parallel and convergent phylogeny.

First: breaking up of the abdominal bands into paired spots, also accompanied by loss of markings on the head and thorax. The final result in this direction is complete loss of color, the insect becoming entirely black, as in many South American and some Ethiopian *Campsomeris*, some of great size, many Ethiopian and some American *Scolia*, and so forth.

In this path the males may retain yellow markings after they have completely disappeared in the females. At the point where complete loss of marking is just being reached, there may be considerable variation amongst the individuals of a species.

Evolution in this direction is shown by the North American *Campsomeris quadrimaculata* (Fabr.). There are two color-forms of the male: one still retains banding on several terga, and nearly hyaline wings. However, the abdominal bands have become deeply incised medially, the first step towards division. The other and more usual male has moved along the same direction as the female. The tergal bands have been lost on all but terga 2 and 3, and have been interrupted on those. The female has gone a step farther, in that the interrupted tergal bands have been reduced to two spots, no longer apical.

The second general direction of evolution of color has been enlargement of the abdominal bands and eventual suppression of some of them, and at the same time reduction of the markings of the head and thorax. In some cases this has been accompanied by a change from light yellow through deep yellow to orange and to red.

The balance of this paper I shall devote to the color-evolution of a series of American species that illustrate this second general evolutionary direction.

Campsomeris plumipes (Drury) of the eastern United States is the beginning.

The pattern is not very different from that of *Campsoscolia octomaculata hermione*, except for less markings on the head and thorax, and for the fact that there is no tendency for the tergal bands to divide medially. The two sexes are alike, except that the second tergal band is broader in the female, and the bands in that sex may be deeper yellow.

Campsomeris pilipes (Saussure) from the western United States is the second. In it the males have not changed, but the tergal bands of the female have so widened as to nearly cover the segments, leaving only a black line at the base of each.

Campsomeris tolteca dives (Provancher) is the next step. The male is just like the male of *plumipes* or *pilipes*. The tergal bands of the female, still broader than in *pilipes*, indeed completely covering terga 2 and 3, have assumed a rich orange-yellow color. This subspecies occurs in the southwestern United States.

In *Campsomeris tolteca tolteca* (Saussure), which occurs in Mexico and the West Indies, the male cannot be distinguished from that of the preceding subspecies, *dives*. But in the female the first tergal band has disappeared, and the color has become orange-red.

In *Campsomeris dorsalis* (Fabr.), Neotropical, the male has still undergone no change, is just like that of *plumipes*, *pilipes* or *tolteca*; but in the female the fourth and fifth tergal bands have disappeared, and terga 2 and 3 have become dorsally entirely bright red. At the same time the wings have usually darkened.

In all of these instances (which are drawn from a single species group) the female alone has followed an evolutionary path, while the male has remained conservative, without change. It is interesting then to see an instance, drawn from another species-group, in which not only has the female reached the state of *dorsalis*, but the male has abandoned its conservatism and has completely caught up with her. The very large *Campsomeris ephippium* (Say) from Mexico is the species to which I refer, and may be regarded as the final step in this particular direction of evolution of color-pattern.

DISCUSSION

Mr. **Kerrich** asks if the condition of a greater amount of bright coloration in the female than in the male, found in a primitive Scoliid, was to be regarded as primitive in the Hymenoptera generally. In a tribe he had been studying this was the usual condition, but the reverse was true for most Ichneumonidae.

Mr. **Bradley**: I do not suggest that it can be carried over into other Hymenoptera, although it is probably true in some groups related to Scoliidae, such as Myzinae.

Mr. **Betrem**: In connection with the question of Mr. KERRICH it is of interest that we have in Australia the primitive genus *Tetrascolia*. The ♂ and

♀ are yellow-brown. Of this colour pattern all possible intermediates are found in Indo-Australia, from lightly coloured to almost entirely black, both females and males. The female, however, being more progressive, often has a much more reduced light colour pattern than the male. It even can be entirely black, while the male has still many yellow spots or bands.

Mr. **Bradley**: This helps to answer the question of Mr. KERRICH. Probably Dr. BETREM will agree with me that *Tetrascolia* is less primitive than *Campsoscolia*.

Mr. **Betrem**: It is difficult to say which of these two genera is the most primitive, because both have many primitive characters in common. Other more primitive properties are not so important that a definite answer can be given now.

Mr. **van Regteren Altena**: Has the colour pattern any functional aspect, e.g., do the males find the females by vision?

Mr. **Bradley**: I am not myself prepared to connect the colour pattern with function. Perhaps Dr. BETREM, who has had wide field experience with Scoliidae in the East-Indies will have some suggestions along this line.

Mr. **Betrem**: It seems to me that in some cases there can be a connection between colour pattern and function. In other, however, such a correlation is not evident. The general brown-yellow colour of the body combined with hyaline yellowish wings occur mostly in dry countries, e.g. Australia, western Pakistan to Palestine, Turkestan and North Africa. Sometimes allied species can be found in a more humid climate with a general yellow-brown colour of the body, but often with dark wings. In this connection a very interesting species is *Scolia erythrocephala* F. with its many subspecies and varieties.

VIVIPARITY IN LEPIDOPTERA

by
A. DIAKONOFF
Leiden, Netherlands

Little attention has been paid in the past to the phenomenon of viviparity in Lepidoptera. Information on this subject available from literature is very scarce, and besides, it has been rather neglected. It is generally understood that this phenomenon is extremely rare in this order of Insects, and that it is due to incidental circumstances.

However, neither of these statements is quite true. To begin with, when studying this scanty information, one gets the impression that viviparity in Lepidoptera is not uniform, but that it manifests itself in three different ways, or rather, in three different gradations; and that it is incidental, certainly not in all these cases. These three different gradations are:

1. Isolated cases of viviparity in some Palaearctic representatives of quite different families of Heterocera, e.g., Geometridae and Psychidae. It is apparently due to premature, anomalous development of the eggs inside the body of the mother insect, and is indeed incidental (e.g., in one case it might have been induced by the presence of an endoparasite).
2. Surmised viviparity in certain species of several genera of Palaearctic Pieridae, described by KUZNETSOV (1910); when studying anatomy in dried material of these butterflies, he observed in certain species from cold regions or high mountains the presence of a dilatation of the oviductus communis which often contained one single developed young larva.
3. Viviparity in tropical species of the genus *Monopis* Hb. (Tinaeidae), observed once in Australia (SCOTT, 1863), and probably once in Brazil (MELDOLA, 1882), where female moths deposited numerous living and active, small larvae.

This last manifestation of viviparity in Lepidoptera is certainly the most interesting, because it is neither due to any anomaly, nor is it incidental. On the contrary, it seems to be the normal way of procreation with these species. Our present study is confined to this last phenomenon.

When studying several species of *Monopis* from Dutch New Guinea we came upon this subject quite incidentally. Dried material of these insects was macerated for taxonomic study, and it was a great surprise to find the female abdomen of every species to be entirely stuffed with minute, but fully developed larvae. Museum material, of course, is not very well suited for close anatomical study, and besides, it was scarce. Consequently, it was not possible to obtain a complete picture of the anatomy of the viviparous species of *Monopis*; still we were able to elucidate several points which are presented here.

It may be emphasized that anatomy of viviparous Lepidoptera has been

studied before only by KUZNETSOV. Though his studies in Pieridae are helpful for the understanding of the anatomy of *Monopis*, the differences are considerable. While in Pieridae one single larva develops in the uterus incidentally, in viviparous *Monopis* the entire progeny of many larvae develops simultaneously within the body of the mother insect.

This very unusual biology leads one to expect considerable specialisation in the anatomy of the female moth. This is indeed the case.

The anatomy of the female reproductive organs of the viviparous *Monopis* may be described as follows (figs 1-2). Almost the entire abdomen is occupied by a large, sausage-like sack which is folded in two above its middle, with the top in about the seventh abdominal segment, running forward as far as the second or even the first segment, suspended there by a strong transverse septum to the body-wall, then runs backwards, and opens in the ovipositor. This sack is the uterus in which numerous larvae are tightly packed. It represents the enormously dilated part of the oviductus communis below the vestibulum. The proximal extremity of the uterus tapers so as to form a narrow tube which communicates with the vestibulum. The latter, which is also a part of the oviductus communis, forms a small chamber in which open the receptaculum seminis and the ductus seminalis, opposite the opening of the uterus. The receptaculum seminis is of normal type: a delicate sack with a narrow, spiral, basal portion; the ductus seminalis is a long tube, often of a very narrow calibre, or with a dilatation along its second quarter, which connects the vestibulum with the ductus bursae. The third organ opening in the vestibulum is the glandula sebacea, an accessory gland, which seems to be reduced or absent altogether. The copulatory organs are of the usual type: a narrow ostium bursae, a moderate ductus bursae with a tubular colliculum, and a pear-shaped bursa copulatrix sometimes armed with numerous thorn-shaped signa.

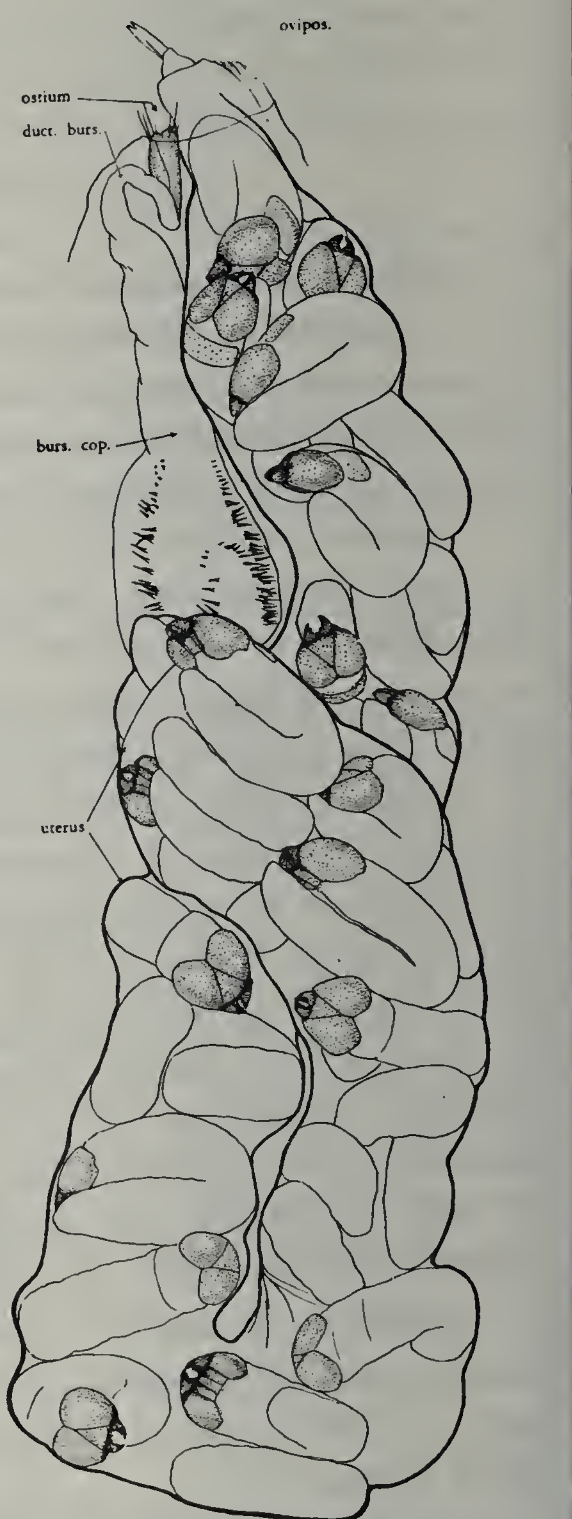

Fig. 1. Viviparous *Monopis* spec. from New Guinea. General view of the contents of female abdomen without further preparation. Uterus stuffed with numerous larvae pushes bursa copulatrix aside.

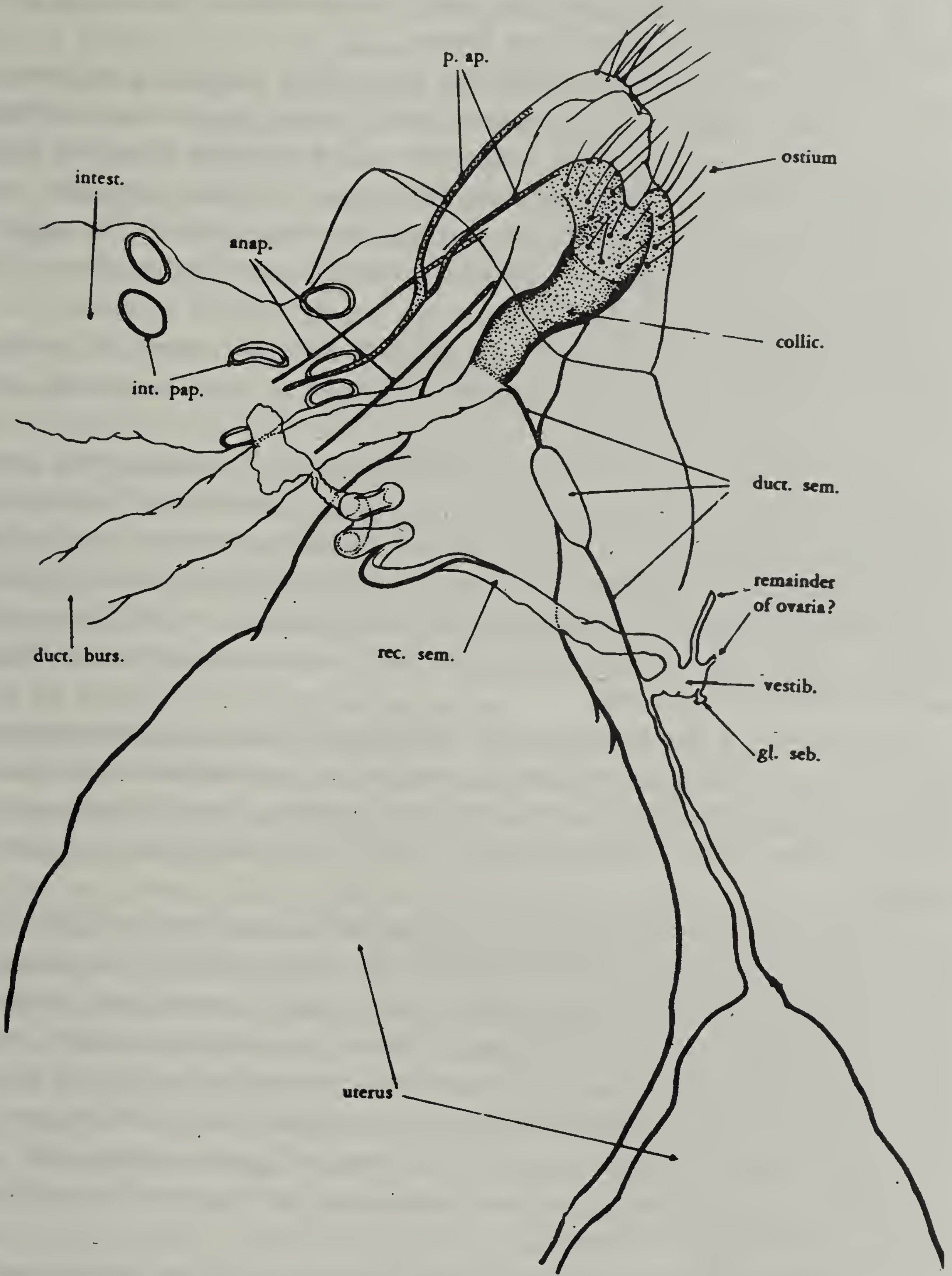

Fig. 2. Detail of reproductive organs of a viviparous *Monopis* spec. from New Guinea. *anap.* = anapophyses, *collic.* = colliculum, *duct. burs.* = ductus bursae, *duct. sem.* = ductus seminalis, *gl. seb.* = glandula sebacea, *intest.* = intestine, *int. pap.* = intestinal papillae, *p. ap.* = postapophyses, *rec. sem.* = receptaculum seminis.

In the wall of the vestibulum between the opening of the receptaculum seminis and that of the uterus opens a fourth narrow tube which must represent the upper, joined portion of the oviducts from both ovaries. This tube is not always traceable, and is mostly very narrow. This may be of great importance, as we shall point out below.

In spite of all the pains we did not succeed in detecting the ovaries themselves. They might have been destroyed by our maceration technique, but it is not likely, as even after treatment with hot water alone we did not find them. Our surmise is rather that at this stage of the insect the ovaries are in a reduced state or are resorbed after the migration of the eggs into the uterus. Their very narrow connection with the oviduct seems to furnish a strong argument for this surmise.

The ovipositor in viviparous species of *Monopis* seems to be in various stages of reduction. It is much shorter than in oviparous species, and sometimes it is almost entirely atrophied.

The numerous larvae are tightlypacked inside the uterus, from its proximal extremity to the very base of the ovipositor. Each larva is folded in two below its middle, with the caudal half tightly appressed to the underside of the rostral half. The larvae of one hatch are all of the same size, and they are always completely developed, with mouth parts, ocelli, legs, warts and bristles. It is evident that the entire hatch develops simultaneously, to be simultaneously deposited.

The number of the larvae varies individually, and probably also specifically, to a considerable extent. In general it can be said that their size is directly proportional to the size of the species, but inversely proportional to the number of the larvae present. The latter varied in our mounts from 9 to 170.

Judging by the entire absence of egg-shells, and by the highly developed uterus, we may readily accept that this is a case of true viviparity, the larvae developing entirely in the body of the mother insect, and being deposited in a "mature" and active state. This is in accordance with the remarkable, but rather neglected and forgotten communication by SCOTT (1863), who in Queensland observed deposition of minute, active larvae of *Monopis meliorella* Walk. which he was able to rear during two subsequent months. It is evident that viviparity is the normal way of procreation in the tropical species of *Monopis* concerned.

It is probable that the development of the larvae in the uterus takes place at the cost of the egg yolk, in the same way as in the normal egg. However, the fact that the size of the larvae is smaller when their number is high, might indicate some other means of nutrition, provided by the body of the mother insect. Still we would rather think that the available space simply forms the limiting factor for the size of the larvae; otherwise the abdomen of the moth might be ruptured.

The point that deserves special attention is that, in all the material studied, even in quite fresh specimens which apparently emerged from the

pupae shortly before their capture, the larvae in the uterus were already in the same far advanced stage of development! If freshly emerged female *Monopis* fly around already gravid with numerous developed larvae, one may ask, at which stage of the mother insect the fertilisation of the eggs and the development of these larvae took place? One has to keep in mind that this development must be lengthy: generation of all the eggs in the ovaries – if our surmise be correct - and further development of the larvae.

In view of these considerations it seems probable, that the viviparous species of *Monopis* must be parthenogenetic. Indeed, of the eight species studied by us only one was represented by the material of both sexes, all others only by females. Furthermore, the bursa copulatrix of all eight species did not contain a spermatophore. In oviparous species of *Monopis* a large spermatophore is always deposited by the male in the bursa copulatrix during copulation. Its absence is a strong indication that the viviparous *Monopis* studied by us have never been fertilized.

However, our surmise of parthenogenesis alone is not enough for the explanation of the far advanced stage of development of the uterine larvae, and we are consequently compelled to make another, perhaps more hazardous supposition. It seems logical that in viviparous *Monopis* the generation of the eggs and their development, and perhaps also the development of the larvae might take place at some pre-imaginal stage of the mother insect, i.e., within its pupal, or even its larval stage!

To answer these questions rearing of the viviparous species of *Monopis* is necessary. Unfortunately neither the full-grown larvae, nor their food are known at present. Therefore, alas, at present we can only postulate these problems, not solve them.

Altogether we found eight species of *Monopis* to be viviparous. These are in fact all the tropical species of the genus which we have so far had the opportunity of studying. Five are from New Guinea, one from Misool Island, one from Celebes and Sumba (*M. trimaculella* Sn.), and one from Java and Sumatra. Most of them have not yet been described. Males are known to us only from the latter species. To this number must be added the "classical" *M. meliorella* Wlk. from Australia, observed by SCOTT. The record of a viviparous "Tineid" in Brazil (MELDOLA, 1882) very probably concerns a species of *Monopis* as well. We do not doubt that most, or perhaps all tropical species of the genus, and also probably many from Australia will prove to be viviparous. Palaearctic species, on the contrary, are oviparous; so is *M. monachella* Hb., a cosmopolitan insect of Palaearctic origin.

The question whether viviparous and oviparous species of "Monopis" are congeneric is open to doubt. We hope to deal with the taxonomy of this group in another place.

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DISCUSSION

Mr. Gouin: Y a-t-il des différenciations spéciales de l'utérus des femelles vivipares? Il semble d'aprés les figures, que la larve se développe dans l'utérus aux dépens des réserves de l'oeuf.

Mr. Diakonoff: Il n'était pas possible de constater quelque adaptation spéciale de la parois de l'utérus, qui est très mince. Comme je l'ai eprouvé à plusieurs reprises, les matériaux déseches ne permettent pas l'examen histologique, qui sera nécessaire pour démontrer de telles adaptations.

En effet il parait probable que les jeunes chenilles se nourrissent au dépens de la reserve d'oeufs, comme je l'ai fait remarquer plus haut.

Mr. Hackman: mentions a case of "ovoviviparity" in a mediterranean *Coleophora* species: Dr. Sergius TOLL found small larvae in the abdomen of a dried female of this insect.

Mr. Diakonoff: thanks for this news and remarks that it is extremely difficult to collect stray notes on this subject which must be widely scattered through literature on biology, faunistics and morphology of Lepidoptera.

Mr. Wilson: asks how the larvae in the uterus obtain nutrition and air from the mother insect?

Mr. Diakonoff: says that for the problem of the nutrition may be referred to his paper itself and to the discussion with Dr. GOUIN. The larvae may obtain additional food as a secretive of the uterus wall, but no special adaptation could be detected. Not dried but rightly fixed or fresh material is necessary for a hystological study. As to the respiration, he can say nothing definite about that, of course, but it seems probable that the larvae get oxygen through diffusion in the same way as in the normal egg before it is deposited.

REMARKS CONCERNING THE FRONTAL PARTS OF THE HEAD OF SOME HYMENOPTERA

by

J. G. BETREM
Deventer, Netherlands

The head of the Scoliids will be described as example because this is thorougly studied by me. In many respects it is specialised, but the more primitive members of the family show many primitive features.

The clypeus is posteriorly limited by the frontoclypeal groove, that can be seen internally as a distinct ridge. It connects the clypeal pits that mark the anterior arms of the tentorium. From these pits a suture runs to the sockets of the antennae, e.g. in *Campsoscolia interrupta* (Fabr., 1781) (= *C. sexmaculata* F., 1781 nec Müller, 1766). This groove seems to be the posterior part of the frontogenal suture (sutura frontogenalis) of DUPORTE (see below). The antennal socket of the Scoliids is altered very much. The inner part of the ring is raised, while the rim of the outer part is reduced. With the more primitive forms this rim is still more or less traceable on the posterior part, e.g. genus *Triscolia*, subgenus *Dielis* s.str. Some related groups show this same or an allied transformation, e.g. Myzinidae, Formicidae. Other ones have normal rims, e.g. Tiphiidae, Brachycistidinae. In the systematics of the Aculeata this feature has drawn too little attention till now. From the tentorial pit a groove runs to the anterior articulation of the mandibles. This is a continuation of the frontogenal suture. DUPORTE has shown that this suture is the external mark of the frontogenal inflection, that is probably present in all insects. This inflection has internally the normal form with the species especially examined by me *(Scolia (Triscolia) procer* Ill.), see fig. 2. The posterior part of the frontogenal suture is not present externally with this species, but the inflection that belongs to it is very distinct internally. The sklerite that lies between the lower part of the frontogenal suture and the compound eye is of a very different shape. In the males of *Campsomeris* it is only a narrow band. It probably forms an entity with the scrobi and the lower part of the sinus ocellaris, because these adjacent parts are often yellow, while the rest of the head is black.

The area frontalis lies in the centre above the clypeus. This is a triangular or rectangular sklerite that may be more or less distinctly limited. Especially in the centre of the back part it is often badly defined. It is present with most of the Aculeata except the Vespids. Especially with the ants it is often separated very distinctly. It sometimes shows its independance by the fact that it is coloured yellow, while the adjacent parts are black, e.g. in *Campsomeris formosa* Guér., male. SNODGRASS considered the area frontalis formally (1928) as the reduced frons of the other insects, that would be limited by the frontal sutures. In his latest publication (1947) he

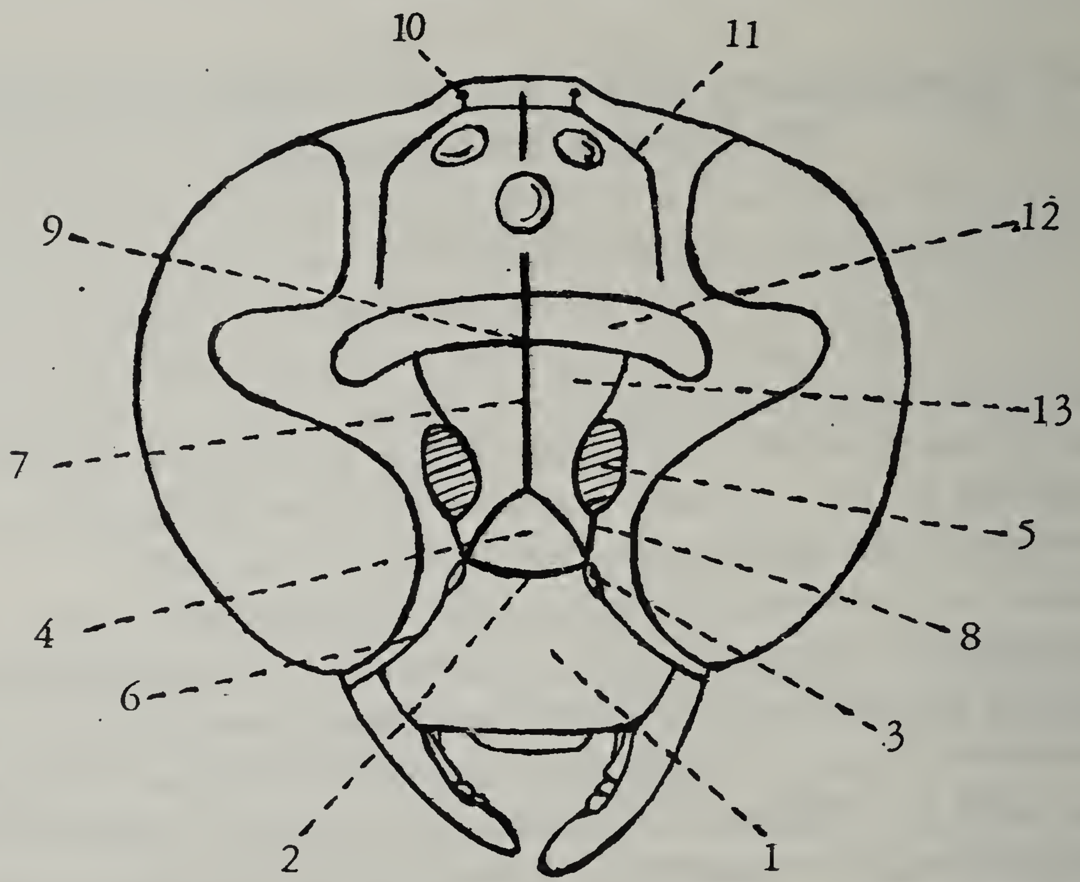

Fig. 1. Front view of the head of *Campsoscolia.* 1. Clypeus. 2. Sutura frontoclypealis. 3. Tentorial pit (anterior tentorial invagination). 4. Area frontalis. 5. Antennal socket. 6. Upper part of the sutura frontogenalis. 7. Fissura frontalis. 8. Lower part of the sutura frontogenalis. 9. Fovea frontalis. 10. Fovea punctiformis. 11. Sutura postfrontalis. 12. Smooth band on the frons posteriorly of the spatium frontale. 13. Spatium frontale

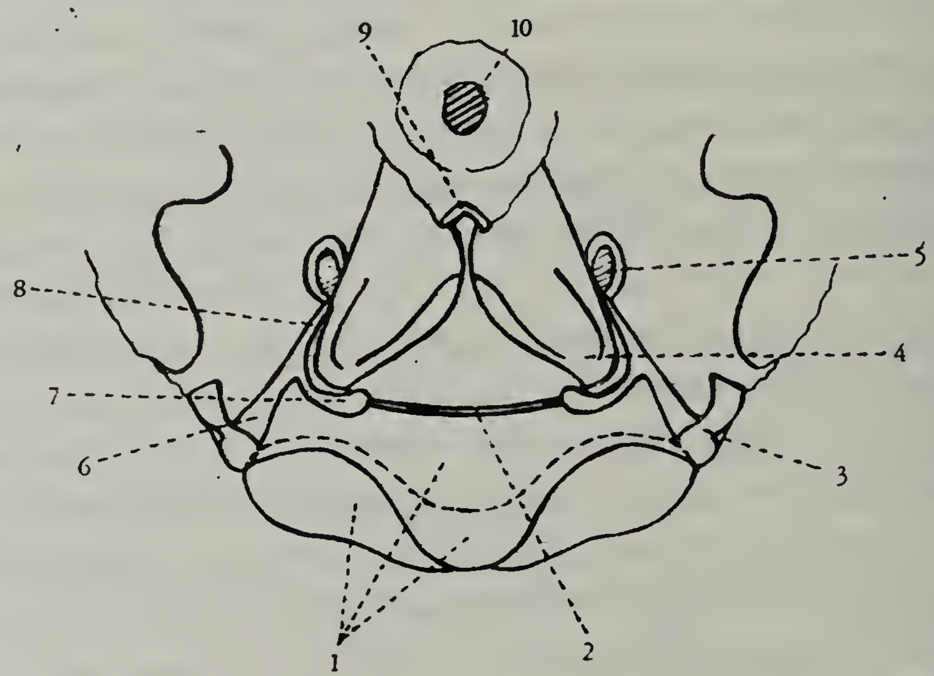

Fig. 2. Internal view of the anterior part of the head of *Scolia (Triscolia) procer.* 1. Clypeus. 2. Frontoclypeal inflection. 3. Insertion of the mandibles. 4. Anterior tentorial arm. 5. Antennal socket. 6. Lower arm of frontogenal inflection. 7. Inner arm of frontogenal inflection. 8. Upper arm of frontogenal inflection. 9. Rim of excavation for the mouth parts. 10. Occipital foramen.

has reprobated this conception entirely *). The remarkable fact that the ecdysis line of the larvae of Aculeata does not fork but runs as a straight line to the clypeus, would affirm the older conception, but I do not think that this is supported by other facts. However, it is remarkable that the fissura frontalis, that originates from the posterior end of the area frontalis and that, according to SNODGRASS, is identical with the ecdysal line of the larvae, never continues on the area frontalis. Internally the fissura frontalis forms a low ridge. It ends behind the posterior ocelli in a transverse groove that is named by MICHA "Ocellarfurche". This groove however appears to extend much farther laterad with the more primitive Scoliids, e.g. *Liacos* female, some *Campsoscolia* species, subgenus *Dielis* s. str.

It exists only as a faint groove or fine line and is only visible on heads that are very smooth. Here it first runs outwards and then bends downwards some distance from the compound eyes. It ends at the height of the sinus ocellaris. According to the course of this suture it can be nothing else than the postfrontal suture (sutura postfrontalis) of CRAMPTON (1921) and of some later authors (SNODGRASS, FERRIS, DUPORTE). It is present with most of the insect orders, and forms the ecdysal line of the larvae. Till now it has never been mentioned of the adult Hymenoptera. However, it is distinct with the larvae of the Tenthredinoidea (YUASA 1922, SNODGRASS 1947). With the larvae of some Aculeata grooves are present that can be considered as remnants of the sutura postfrontalis.

Laterad of the posterior ocelli a shallow small groove is often in existence, the lateral ocellar groove. In this groove very often a posterior wall is differentiated by a fine line that is a part of the postfrontal suture. The two parts are sometimes placed almost perpendiculary with regard to each other.

The coronal line is but rarely present. Only with the subgenus *Triscolia* it is often distinct. These lines originate laterad of the posterior ocelli from the sutura postfrontalis, and run backwards. They each end in a small pit-like groove, fovea punctiformis, that is called "Punktgrube" by MICHA. Probably these fine sutures can be compared with those that define the central part of the vertex of the Tenthredinidae.

The Scoliid head has still more remarkable features, e.g. the spatium frontale that lies between the antennae and that is defined anteriorly by the area frontalis, laterad by the lamina frontalia that are the raised inner rims of the antennal sockets, posteriorly often by a fine line. On the point of intersection of this line and the fissura frontalis a groove is often found, fovea frontalis (by MICHA called "Stirngrube"). Often this has a different structure than the rest of the front. Probably this is a relict of the broad, smooth band that is present in some *Campsoscolia* species.

*) In accordance with the original conception of SNODGRASS I had named subvertex (1935) the part of the head of the Hymenoptera that is generally called frons. Because the real frons now appears not to be the area frontalis, this name has no reason of existence any more.

Probably these last mentioned characters are of little value for the understanding of the head of the Hymenoptera, on the whole, because they are only present with the Scoliids and some allied groups.

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DISCUSSION

Mr. **Richards:** Has there not been so much development of secondary sutures in Hymenoptera that it is very dangerous to draw homologies? Are the Scoliidae not really less primitive than Dr. BRADLEY and Dr. BETREM suggested? The Tiphiidae are more primitive.

Mr. **Betrem.** The sutures agree very well with those of other insects. No family is all primitive but exhibits a mixture of primitive and specialized characters.

SUBGENERIC DIVISION OF THE GENUS BOMBUS LATR.

by

G. KRUSEMAN
Amsterdam, Netherlands

In the genus *Bombus* Latr. many species are described, but many of these "species" have only subspecific or even infra-subspecific rank. There remain about 250 species which are arranged in about 33 subgenera. Many of these subgenera are monotypical.

If the system of the Humble-bees was clear after the description of all these subgenera, one would not oppose this system. But in my opinion by describing so many subgenera we are only obscuring the relations.

After KRÜGER, 1920, divided the genus *Bombus* in two divisions: *Odontobombus* and *Anodontobombus*, SKORIKOV recognized not less than 19 genera. Nobody has followed SKORIKOV, and all students agree that the genus *Bombus* must not be split into smaller genera. In 1927 FRISON divided *Bombus* in three sections separating the section *Boopobombus* from *Anodontobombus*. The section *Boopobombus* took the place of *Bombias* Robertson in the sence of FRANKLIN, 1913.

Many students have already given as their opinion that *Boopobombus* is a combination of subgenera, which have little relation to each other. In my opinion it is possible to split the genus *Bombus* in three sections, but the third section must have other limits than those given to *Boopobombus* by Mr. FRISON. I think that *Confusibombus* Ball, 1914, *Mendacibombus* Skor., 1914 and *Nevadensibombus* Skor., 1922 are very nearly related, but the other subgenera as *Cullumanobombus* Vogt, 1911, *Fraternobombus* Skor., 1922 and *Sibericobombus* Vogt, 1911 have nothing to do with the three first named subgenera.

As it is better not to use the same name in different meanings, I propose to use *Bombias* Robertson for the section containing *Nevadensibombus, Confusibombus, Mendacibombus* with the type *B. auricomes* Robertson, 1903.

The caracteristics of this section are:

♀. The very long third joint of the antenna; the mainkeel ending before the tip of the jaws. The labium has a transverse depression, which is not very clear in *Confusibombus*.

♂. Sagitta straight, combined with swollen eyes.

These characters delimit this group very clearly from the other subgenera of *Boopobombus*. It is a small group with only about seven species.

The rest of the genus Bombus should be divided into the two sections created by Mr. KRÜGER: *Odontobombus* and *Anodontobombus*.

Even in the old system we can suppress some subgenera as synonyms, as for instance: *Senecibombus* Frison, 1930 which should be incorporated in *Hortobombus* Vogt, 1911 and *Fraternobombus* in *Sibericobombus*.

The figures of the male genitalia show, that there is practically no difference. But I should like to suppress more subgenera. I propose to put together: *Senecibombus* and *Diversobombus* with *Hortobombus* as I think the differences are to small to separate the genera from each other. In the same way *Mucidobombus*, Skor., 1922, *Laesobombus* Skor., 1922 and *Adventoribombus* Skor., 1922 should be incorporated in *Agrobombus* Vogt, 1911. In the section *A o-dontobombus* the subgenera *Alpinobombus* Skor., 1914, *Bombus* Latr., 1802, Vogt, 1911, *Terrestribombus* Vogt, 1911 = *Bombus* s.str.L., *Soroeensibombus* Vogt, 1911 and *Orientalobombus* Richards, 1929 may be retained in their old limits. In *Lapidariobombus* we may incorporate *Kozlovibombus* Skor., 1922, *Pressobombus* Frison, 1935 and *Tanguticobombus* Pitti, 1939, till more data are available. The difficulty is what to do with the group *Uncobombus* of KRÜGER. This group is characterised by a sagitta which is curved inwards as the handle of a walking stick.

It would be possible to put all these subgenera *Cullumanobombus* Vogt, 1911, *Rufipedobombus* Skor., 1922, *Pratobombus* Vogt, 1911, *Alpigenobombus* Skor., 1914, *Fraternobombus* Skor., 1922, *Funebribombus* Skor., 1922, *Robustobombus* Skor., 1922, *Coccineobombus* Skor., 1922 and *Separatobombus* Frison, 1927, *Sibericobombus* Vogt, 1911 and *Obertobombus* Reinig, 1930 together, but when we get a subgenus which contains the greater part of all the species of the genus. We may separate *Alpigenobombus* by the remarkable jaws of the ♀♀ which are unique in this genus.

We may preserve *Pratobombus* which is already a subgenus with many species.

We may incorporate in *Sibericobombus*, the subgenera *Fraternobombus*, *Obertobombus*, *Robustobombus*, and probably *Coccineobombus* and *Funebribombus*. In this way there remain *Cullumanobombus*, *Rufipedobombus* and *Separatobombus*, which are more insolated.

It is perhaps possible to incorporate *Separatobombus* in *Pratobombus*, for their genitalia are very much alike, but *Separatobombus* has bulging eyes.

But we certainly must not describe without very good reasons new subgenera on one aberrant species only.

DISCUSSION

Mr. **van Regteren Altena**: There is one point in which I think I seriously disagree with you, as you said you did not like to mention a subgenus containing but one species and on the other hand divided a subgenus into several ones because it contained too many species. In my opinion monotypic and large subgenera cannot be eliminated in a really natural classification.

Mr. **Kruseman**: I should agree with Dr. v.Regteren Altena if we had a real ancestral classification, but as the subgeneric classification is based only on morphological characters it is purely artificial. The classification must be practical. We must have very good reasons for erecting a new subgenus for one species, and must know the male and the female. Some subgenera in *Bombus* are erected on incompletely known specimens.

Mr. **Richards**: Would it not be better to take more notice of the structures of females?

Mr. **Kruseman**: It would be better, but it is not yet possible.

MUSCULATURE, MEMBRANE „BASALE" ET TEGUMENTS CHEZ LA LARVE DES DIPTERES STOMOXYS CALCITRANS L. ET CHIRONOMUS CINGULATUS M.G.

par

François GOUIN

Strasbourg, France

PÉREZ, dans son mémoire (p. 197 et 202) désormais classique (cf. WEBER, p. 25, fig. 21), a décrit en détail les deux modes d'insertion tégumentaire des muscles: le type „simple" et le type „associé". A propos de la „basale", il signale qu'elle recouvre l'épithélium cuticulaire et les muscles; il l'appelle donc soit „basale", soit „sarcolemme". FAHLANDER (p. 15, fig. 3-5) a repris la question à propos de son étude sur les Chilopodes et distingue deux éléments de la „basale": une limitante vers la cavité générale (appelée „cutis" à la suite de HEYMONS) et une „cuticule interne" située entre la „cutis" et l'épiderme et contribuant à former le tendon musculaire. Notre communication verse à ce dossier de nouveaux documents.

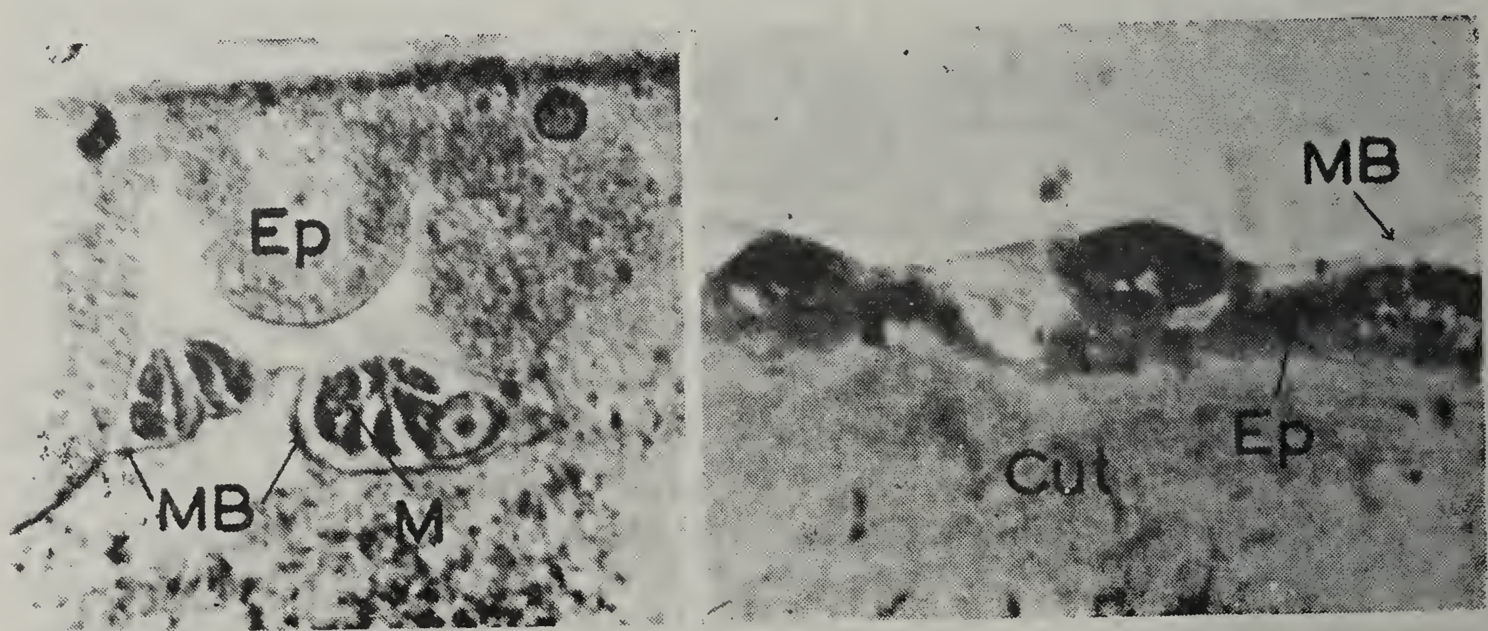

Fig. 1a. *Chironomus cingulatus* M.G., larve, rectum antérieur. Relations de la „basale" avec les fibres musculaires circulaires (M) et l'épithélium (Ep.). Un noyau se voit dans l'un des faisceaux de muscles. Microphoto. 1b. *Stomoxys calcitrans* L. Larve. Tégument: rapports de la „basale" (MB) avec l'épiderme (Ep.) et la cuticule (Cut), en partie non figurée. Microphoto.

Les microphotos (fig. 1) et les dessins à grande échelle donnent une vue d'ensemble sur les insertions musculaires et les relations de la „basale" chez un Nématocère (*Chironomus*) et un Muscide (*Stomoxys*). L'on reconnait facilement les détails histologiques décrits par PÉREZ: le tendon commun, la zone tonofibrillaire épidermique, la zone fibrillaire cuticulaire, conique et à direction perpendiculaire à la stratification endocuticulaire. La larve de

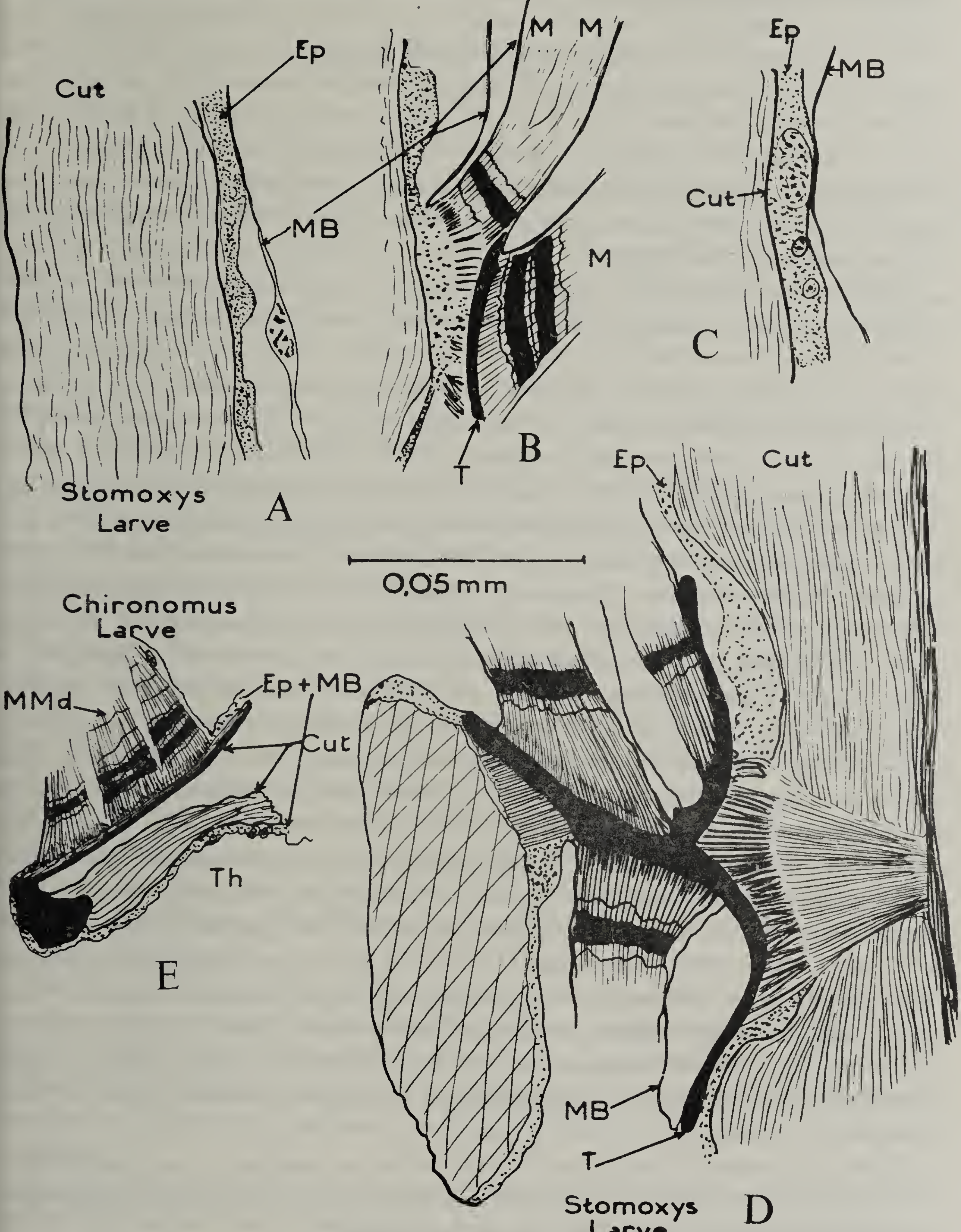

Fig. 2A-D. Relations de la „basale", des muscles et du tegument chez les larves de *Stomoxys calcitrans* dans la region abdominale. En B et C, la cuticule n'est pas représentée dans toute son épaisseur. Fig. 2E. Larve de *Chironomus cingulatus* MG. Insertion directe du muscle mandibulaire (M Md) sur la capsule céphalique. Cut: cuticule; Ep: épiderme; épithélium; M: muscle; MB: „basale"; T: tendon; Th: thorax.

Chironomus nous donne un exemple du type d'insertion simple (fig. 2). Les insertions tégumentaires des muscles abdominaux chez cette larve et chez celle de *Macropelopia nebulosa* MG. donnent des images tout-à-fait comparables à la fig. 3, pl. 1 de FAHLANDER. La zone intermédiaire entre l'epiderme et le muscle ressemble beaucoup à la „cuticule interne" de cet auteur; mais elle ne se prolonge pas au delà de l'insertion musculaire, où la „basale" est directement accolée à l'épithélium. Il semble donc qu'il faille interpreter cette „cuticule interne" comme une différenciation ou un élément sarcoplasmique. Digne d'être signalé est d'autre part le fait que le type „associé" ne se rencontre pas chez les larves de Nématocères, tout au plus en en constate-t-on une ébauche.

Plus remarquable est le comportement de la „basale", dont les figures donnent quelques modalités. Elle se présente tout d'abord comme un élément assez épais, passablement colorable. Il semble d'autre part que des inclusions, colorées comme des éléments nucléaires, se rencontrent de place en place; mais il est très difficile d'être affirmatif quant à leur nature nucléaire. Généralement cette „basale" est accolée à l'épithélium cuticulaire et intestinal, „double" les divers organes de la cavité générale; au niveau des insertions tégumentaires de la musculature, il apparait nettement que la „basale" épidermique se continue dans la „basale" musculaire, où elle prend le nom de sarcolemme. Un examen approfondi des coupes nous montre en certains endroits un autre comportement dont nous donnons des exemples (fig. 1 *Chiromus* et fig. 2 *Stomoxys*). Il arrive en effet que la „basale" se dissocie de l'épiderme et en reste indépendante tout en se raccordant au „sarcolemme". Sur d'autres préparations de la même larve l'on voit que ce „sarcolemme" est lui aussi indépendant du muscle: c'est le cas. p. ex., dans la figure 2 et la figure 1 (*Stomoxys* et *Chironomus*). Nous avons fait allusion à ces faits dans notre mémoire de 1947 (cf. plus spécialement p. 356, fig. XVIII). La figure 1 illustre l'indépendance de ce „sarcolemme" par rapport au muscle: la fibre longitudinale du rectum antérieur chez la larve de *Chir. cingulatus* apparait nettement doublée vers la cavité générale; vers l'épithélium rectal par contre, elle n'est limitée que par la membrane cytoplasmique musculaire. Très instructifs sont les rapports de la membrane „basale" avec les parois du sinus sanguin du cardia chez la même larve (GOUIN, 1947, p. 350, fig. XII); elle les tapisse intérieurement et elle apparait encore indépendante de la membrane cytoplasmique musculaire, surtout dans la partie apicale.

Tout cet ensemble de faits d'observation ne senblent pas favorables à l'hypothèse d'une production épidermique, mais s'interprète plus facilement si l'on admet la nature conjonctive de la „basale".

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ZWEITEILIGE VORDERTARSEN BEI ATTAPHILEN PHORIDEN-WEIBCHEN ALS MYRMECOPHILE ANPASSUNG (Dipt. Phoridae)

von

T. BORGMEIER, O.F.M.
Petropolis, Brasilien

In der rein systematischen oder taxonomischen Literatur findet man oft vergleichend-morphologische Bemerkungen eingestreut, welche für die Beurteilung allgemein-biologischer Fragen von der grössten Bedeutung sind. Solche Bemerkungen bleiben leicht unbeachtet und geraten in Vergessenheit, falls man sie nicht ans Licht zieht und der grossen Öffentlichkeit bekannt macht.

Eben das beabsichtige ich mit dieser kurzen Mitteilung, die sich auf eine Beobachtung bezieht, die ich bereits vor 22 Jahren veröffentlicht habe. Im Jahre 1929 beschrieb ich im „Zoologischen Anzeiger" (WASMANN-Festband) eine neue südamerikanische Fliegen-Gattung, die ich *Myrmosicarius* nannte. Sie gehört zur Familie der Phoriden, die sich durch ausserordentlichen Formenreichtum auszeichnet und deren Kenntnis besonders durch die zahlreichen Arbeiten des Pater Hermann SCHMITZ, den unter meinen Zuhörern zu sehen mir eine besondere Ehre ist, gefördert wurde. In mehr als 200 Arbeiten hat P. SCHMITZ für diese Familie ein so solides Fundament gelegt, wie es für wenige Insektenfamilien der Fall ist. Und ich glaube, meine Herren, Sie werden mir zustimmen, wenn ich die Gelegenheit benütze, dem unermüdlichen Forscher auch an dieser Stelle zu versichern, dass ihm der Dank der gesamten wissenschaftlichen Welt gebührt für seine ausgezeichneten Publikationen über diese schwierige Dipterengruppe, womit ich zugleich den Wunsch verbinde, dass es dem noch rüstigen, wenn auch bereits 72-jährigen Forscher vergönnt sein möge, seinen grossen Beitrag für das monumentale Werk Dr. LINDNERS „Die Fliegen der paläarktischen Region" zu einem guten Ende zu führen.

Nach dieser kurzen Digression komme ich auf mein Thema zurück. Die Gattung *Myrmosicarius* ist myrmecophil, wie schon der Name andeutet. Bisher sind zehn Arten beschrieben: acht davon parasitieren Blattschneiderameisen der Gattungen *Atta* und *Acromyrmex*; eine (*diabolicus*) wurde bei *Solenopsis saevissima* gefunden, und eine andere (*biarticulatus*) bei *Eciton praedator*.

Das Merkwürdige bei dieser Gattung ist nun, dass bei den Weibchen aller Arten die Vordertarsen zweigliedrig sind. Dieser Fall ist einzig dastehend unter mehr als 100 Fliegenfamilien mit Hunderttausenden von Arten. Während bei den Käfern die Zahl der Tarsenglieder schwankt (3-5), sind die Tarsen bei allen Fliegenfamilien fünfgliedrig. Die einzige Ausnahme bildet die Gattung *Myrmosicarius*, deren weibliche Vordertarsen zweigliedrig sind.

Wir haben hier einen interessanten Fall von Adaptiogenese vor uns. Die

Tarsenglieder der Vorderbeine sind beim Weibchen sekundär zusammengewachsen und das letzte Glied der Vorder- und Mitteltarsen ist zugespitzt infolge der Funktion des Tastens bei der Eiablage. Die Weibchen von *Myrmosicarius* verfügen nämlich über einen langen chitinisierten Ovipositor, worin der eigentliche Legestachel verborgen ist. Mit letzterem suchen die Phoriden wie mit einer Injektionsnadel den Ameisen ein Ei einzuspritzen, vermutlich zwischen Kopf und Prothorax durch die Halsmembran, wie es für die Gattung *Neodohrniphora* durch die Beobachtungen EIDMANNs feststeht. Bei dieser Operation fungieren die Füsse, besonders die vorderen, als Tastorgane. So erklärt sich zwanglos die zugespitzte Form des letzten Tarsengliedes mit den winzigen Krallen und Pulvillen, sowie auch die teilweise Verwachsung des Vordertarsus.

Gestatten Sie, dass ich Ihnen jetzt einige Bilder vorführe, damit Sie von dem Gesagten einen konkreteren Begriff bekommen.

Der Vortragende zeigte projizierte Diapositive folgender Arten: *Myrmosicarius infestans* Borgm., Gesamtansicht des Weibchens; *M. grandicornis* Borgm., Fühler ♀; *M. infestans* Borgm., Fühler ♀; *M. diabolicus* Borgm., Hinterbein ♀; *M. persecutor* Borgm., Mittelbein ♀; *M. biarticulatus* Borgm., Vorderbein ♀; *M. grandicornis* Borgm., Vorderbein ♀. Alle Bilder wurden bereits in den unten angegebenen Arbeiten des Vortragenden veröffentlicht.

Die Gattung *Myrmosicarius* macht durchaus den Eindruck von etwas Gewordenem. Sie ist deshalb auch entwicklungstheoretisch von grossem Interesse. Während sonst das Organ die Funktion bestimmt und der Funktion vorausgeht, hat es in diesem Falle ganz den Anschein, als habe die Funktion des Tastens ein schon bestehendes Organ (nämlich die Füsse) umgeformt oder transformiert. Wie ein solches Wunder der Umkonstruktion, und sei es auch nur eines einzigen Organs, nun überhaupt möglich ist, wird wohl immer ein Geheimnis bleiben. Aber es ist doch interessant, sich Gedanken darüber zu machen. Ich persönlich bin überzeugt, dass alle rein mechanistischen „Erklärungen", wie sie in neuerer Zeit besonders von den Neodarwinisten HUXLEY, SIMPSON und RENSCH versucht werden, in die Irre führen, weil es einfach nicht einleuchtet, dass aus Zufall etwas Geordnetes entstehen kann.

Es würde zu weit führen, auf die allgemeinen Fragen, die hiermit zusammenhängen, einzugehen. Wer sich dafür interessiert, dem rate ich, das ausgezeichnete Werkchen zu lesen, welches die berühmte deutsche Naturphilosophin Frau Dr. Hedwig CONRAD-MARTIUS unter dem Titel „Die Abstammungslehre" herausgegeben hat.

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DISCUSSION

Mr. **Hering**: Könnten etwa die umgebildeten Tarsen als Führung für den Ovipositor bei der Eiablage dienen?

Pater **Borgmeier**: Der bekannte Ovipositionsakt bei verwandten Gattungen spricht dagegen.

Pater **Schmitz**: Fragt ob jemandem der anwesenden Dipterologen vielleicht ein weiteres Beispiel von numerischen Reduktion der Tarsenglieder bekannt sei. Wie steht es mit *Ascodipteron?*

Mr. **Lindner**: bemerkt dass dort das ♀ überhaupt fusslos sei.

Mr. **Roepke**: Weist darauf hin, dass ein ähnlicher Fall bei den Süd-Amerikanischen Paussiden vorliegt. Alle Paussiden haben, als caraboïde Käfer, einen 5-gliederigen Tarsus, mit Ausnahme der wenigen, aus Südamerika bekannten Arten, bei denen der Tarsus 3-gliederig ist. Leider ist nichts über die Lebensweise bekannt, sodass man nicht sagen kann ob diese Reduktion des Tarsus etwas mit der Myrmekophilie zu tun hat.

Mr. **van Emden**: Ich weiss unter den Dipteren augenblicklich auch nur das Weibchen von *Ascodipteron*, das keine 5-gliederigen Tarsen hat. Vielleicht sei der Tarsus der besprochenen Phoriden ein Klammerorgan.

ESQUISSE DE LA MORPHOLOGIE DE LA TETE LARVAIRE DE PRODIAMESA OLIVACEA MG. (Dipt.Nemat.Chironom.)

par
Francois GOUIN
Strasbourg, France

La structure de la tête larvaire des Nématocères présente de notables particularités dont l'interprétation morphologique, déjà délicate en elle-même, est rendue plus difficile encore par les désignations purement topographiques des divers éléments constitutifs utilisés en systématique.

La tête prognathe de la larve de *Prodiamesa olivacea* (cf. COMAS, pp. 174-178; GOETHGEBUER p. 154, fig. 271 a) est une capsule légèrement bombée dorsalement et plate ventralement. La partie dorsale est formée presque entièrement d'une pièce médiane dont la forme rappelle vaguement un triangle. Le sommet de ce triangle touche le bord postérieur formé par un postocciput presque virtuel. Cette pièce médiodorsale, nettement séparée des latérales par une suture frontale, porte tout à l'arrière les origines des muscles labraux et dilatateurs pharyngiens; tout à l'avant, entre l'insertion des antennes, les origines des muscles cibariaux. Cette pièce médiane (clypéus auct.) est le front, et le clypéus ppt. dit n'en est que la zone antérieure, la suture clypéo-frontale (épistomale) n'étant pas apparente. Les parties dorsolatérales postérieures sont du domaine mandibulaire.

La paroi ventrale comprend l'étroit postocciput autour du large foramen sur lequel se fixent deux courts bâtonnets tentoriaux portant l'insertion du muscle thoracique et l'origine du muscle labial. Les parties latérales situées en avant sont du domaine maxillaire. La partie médiane entre le postocciput et le bord antérieur représente une sorte de gula formée par la coalescence des postgenae et du submentum. Le bord antérieur denté de ce sclérite est communément appelé labium (submentum, COOK) et présente chez *Prodiamesa olivacea* (comme chez les Chironomiens) des différenciations chitineuses, les „plaques paralabiales" qu'il serait plus correct d'appeler „paragulaires" (fig. 1 et 2, P Plb).

Le labium s. str. (fig. 1 et 2 Lb) est presque entièrement membraneux et caché par la gula. Une seule paire de muscles (M Pm) s'insère sur une faible sclérite: ce sont les muscles prémentaux, dont l'origine se trouve sur le postocciput. La partie antérieure à cette insertion, garnies d'éléments sensoriels divers: bâtonnets, soies, lamelles, pourrait représenter les lobes et les palpes, dont les territoires très difficiles à délimiter seraient en tout cas fort réduits. Une pièce chitineuse (désignée par „X" sur la figure 2) relie la partie basale de ce labium membraneux à la partie antérieure de la gula: peut-être doit-on y reconnaître le submentum, si l'on adopte l'hypothèse suggerée plus loin sur la formation de la capsule céphalique.

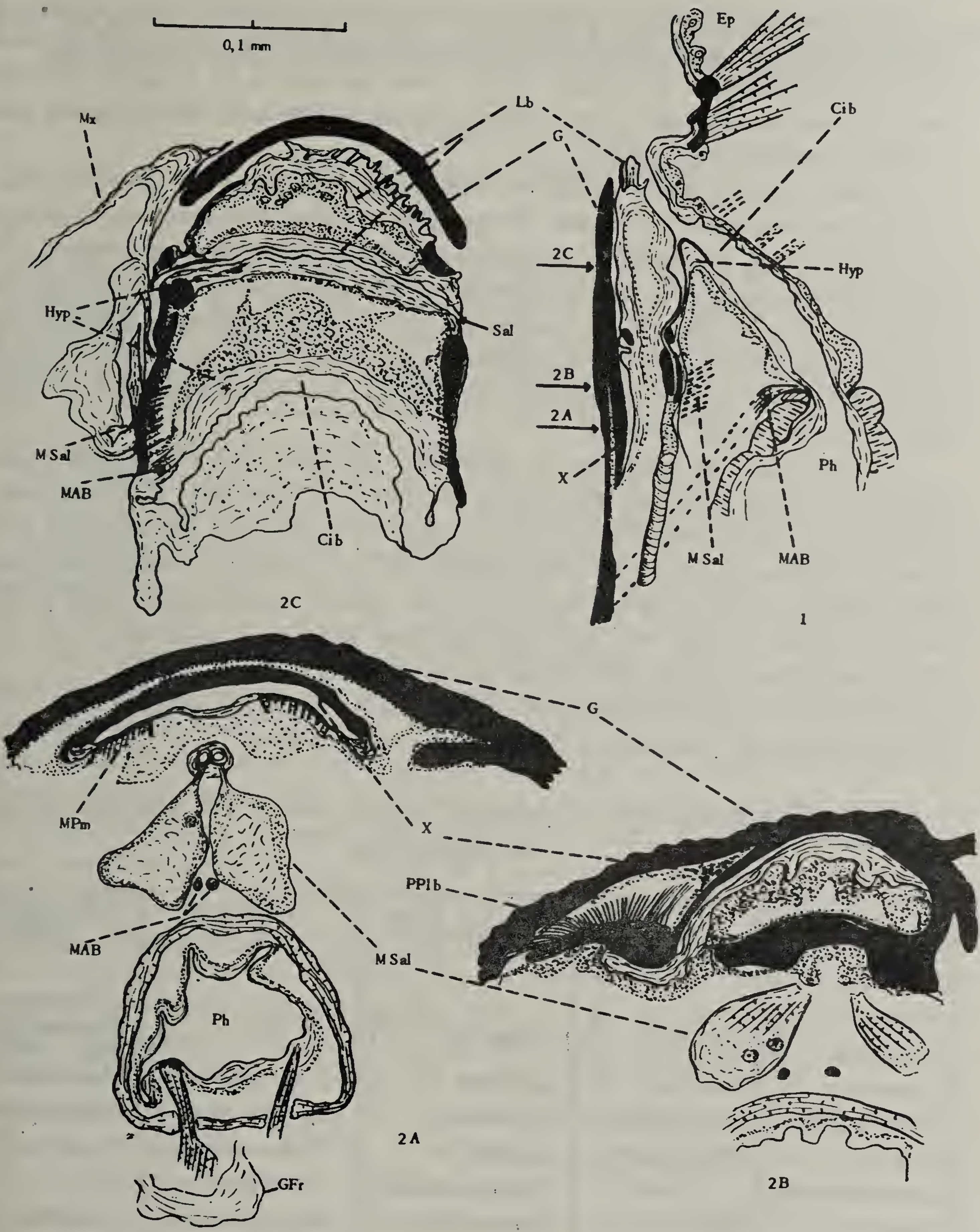

Fig. 1. Coupe sagittale à peu près médiane. Eléments nerveux du labium non figurés. L'épithélium est représenté en pointillé, les sclérites en noir les membranes par des lignes parallèles. En traits interrompus, projection des muscles cibariaux de la pompe salivaire et du prémentum non rencontrés par la coupe. Ep: épipharynx, insertions des muscles labro-épipharyngiens. Autres lettres: voir texte.

Fig. 2. Coupes transversales passant aux niveaux indiqués sur la fig. 1. Mx: maxille

L'hypopharynx (Hyp) est séparé du labium par un profond sillon au fond duquel débouche la canal salivaire (Sal) perçant un sclérite transversal en forme de V. Immédiatement en arrière de ce point se trouve la soupape salivaire dont les deux muscles se fixent sur un sclérite differencié dans la paroi même de l'hypopharynx (fig. 2a).

Le tube digestif, dans sa partie céphalique, comprend un cibarium (fig. 1 et 2 Cib) relativement court doté de quelques faibles faisceaux et un pharynx reconnaissable à son épaisse tunique musculaire. Le dilatateur ventral s'insère immédiatement en avant du premier anneau musculaire (fig. 2 MAB). Nous le désignons par „muscle de l'angle buccal". Les dilatateurs dorsaux, plus puissants, sont situés après le ganglion frontal (fig. 1 et 2). Chez les formes carnassières, p. ex. les Tanypinae, le pharynx est très extensible et pourvu de muscles disposés en croix.

Le processus de formation de cette tête larvaire peut être jalonné par la constitution des têtes de *Mycetobia, Rhyphus, Trichocera, Philosepedon* et *Ptychoptera*, récemment décrite par ANTHON. Certains Chironomides représentent également un stade peu évolué: tel par exemple *Protanypus morio*, dont la partie médioventrale de la tête est restée membraneuse. Les processus de formation de la tête larvaire pourraient donc bien avoir été

1. une prolifération des parties latérales de la tête,
2. leur coalescence entre elles et avec certains éléments labiaux et
3. une translation des parties postérieures vers l'avant.

Tableau des synonymies de quelques termes relatifs à la tête des larves de Nematocères

GOUIN	Auct.	COOK 1949	ANTHON 1943	SCHREMMER 1950
Vertex				
Frons Clypeus }	Clypeus }	Clypeus }	Frons }	Clypeus (Fronto-clypeus 1949)
Labrum	Labrum	Labrum	Labrum	Labrum
Epipharynx	Epipharynx	Palatum	Epipharynx	Epipharynx
Labium (Praementum)	Hypopharynx	Labium (Praementum)	Praementum + mentum	Labium
Gula	Labium	Submentum	Hypostomium Hypostomal-brücke	„Mentum"

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DAS FEHLENDE BINDEGLIED ZWISCHEN DEN DIPTERENFAMILIEN PHORIDAE UND TERMITOXENIIDAE IN AFRIKA GEFUNDEN

von

H. SCHMITZ, S. J.

Bad Godesberg, Deutschland

Es handelt sich bei dieser Mitteilung um eine wichtige neue Unterlage zur Beurteilung der seit 50 Jahren diskutierten Frage: gehören die von P. Erich WASMANN, S.J., 1900 zuerst bekannt gemachten Termitoxenien, von denen bisher 31 Arten beschrieben wurden, systematisch zu den Phoriden, oder besteht die Familie Termitoxeniidae zu Recht, die WASMANN, 1901 errichtete? Der Status quaestionis ist kurz folgender.

Die Termitoxenien sind kleine, nur in der alten Welt und nur in den Nestern von pilzzüchtenden Termiten lebende Fliegen mit stark reduzierten, ± stabförmigen Flügeln und sackförmigem Abdomen, dessen Terminalia stets bauchwärts weit nach vorn bis in die Nähe der Hinterhüften verlagert sind. Sie gehören, wie die Phoriden, zur Abteilung der Diptera aschiza und sind mit den Phoriden sicher näher als mit irgendeiner andern Familie verwandt. Nach WASMANN sollen sie erstens ametabol und zweitens proterandrische Hermaphroditen sein. Ametabol sind sie jedoch nicht. Von 2-3 javanischen Arten sind Eier, Larven und Puparien heute genau bekannt. Die Larve des ersten Stadiums steht beim Schlüpfen aus dem Ei schon unmittelbar vor der Häutung, die Larve II nimmt keine Nahrung zu sich, das dritte Stadium fällt ganz aus. Das ganze Leben als freie Larve dauert nur wenige Minuten bis einige Stunden, je nach der Art. Aus dem Puparium schlüpft eine sehr kleine, unfertige Imago mit beiderlei Geschlechtsorganen, mit reifem Sperma und noch wenig entwickelten Ovarien. Das ist die männliche Phase. Diese macht innerlich und äusserlich eine längere und je nach der Gattung mehr oder weniger tiefgreifende Umbildung durch, zeigt also eine „postmetabole" oder „imaginale" Entwicklung, durch die insbesondere der Hinterleib einen ungewöhnlichen Umfang erreicht. So entsteht die zweite, die weibliche Phase, mit voll entwickelten Ovarien. Das Imaginalleben beginnt also mit einem sehr kleinen Stadium, das wegen der geringen Dimension seines Abdomens das stenogastre genannt wird; dann kommen verschiedene Entwicklungsstufen und zuletzt das voll ausgewachsene, sogenannte physogastre Stadium. Die Physogastrie ist hier nicht etwa eine blosse, reversible Hinterleibsdehnung; sie ist vielmehr mit einer derartigen Ausgestaltung der Körperdecke, oft auch des Kopfes und der Beine verbunden, dass man sich wundern muss, wie so etwas ohne Häutung überhaupt möglich ist.

Dies alles wissen wir teils durch WASMANNs und ASSMUTHs Arbeiten, teils durch Beobachtungen und Züchtungen von Dr. C. FRANSSEN und parallel laufende anatomisch-histologische Untersuchungen von Dr. O. MERGELSBERG.

Der von WASMANN seit 1901 behauptete, aber gegen kritische Einwände nicht gesicherte proterandrische Hermaphroditismus ist also heute zweifelsfrei bewiesen.

Wenn der Hermaphroditismus genügte zur Trennung der Termitoxenien von den Phoriden, was ich nicht glaube, so wäre der Widerspruch, den BRUES (seit 1903), SILVESTRI, BUGNION, KERTÉSZ, KEILIN, IMMS gegen WASMANN erhoben, zugunsten WASMANNs erledigt. Man konnte WASMANNs Auffassung bisher aber auch auf andere Weise stützen und dabei von der Zwittrigkeit ganz absehen. Man konnte darauf hinweisen, dass zwischen Phoriden und Termitoxenien rein morphologisch eine tiefe Kluft bestehe, und zwar, trotz anderthalbtausend seit 1900 in allen Weltteilen neuentdeckten Phoriden — darunter viele ganz aberrante Formen — eine Kluft ohne Brücke. Um nur einige Merkmale zu nennen: Mundteile ohne Hypopharynx, mit Stechborsten, die scheinbar an Tabaniden erinnern; Beine ohne Feinbehaarung, aber mit allseits abstehenden langen Borstenhaaren; Flügelstummel mit allseits beborsteter Costalis und kompakten Vorderrandadern; einen Endtubus am Bauchgrunde: das alles fand man bei Phoriden nirgends. Seitdem ich 1916 auf diese Tatsachen hinwies und die Selbständigkeit der Familie Termitoxeniidae damit verteidigte, gewann WASMANNs Ansicht wieder mehr Anhänger. Auch der Londoner „Zoological Record" konnte sich bis heute nicht entschliessen, die Phoriden und Termitoxeniiden unter einen Hut zu bringen.

Aber obschon ich bisher die Termitoxeniidae als eigene Familie verteidigt habe, kann ich sie heute nur als Subfamilie der Phoriden gelten lassen. Ich habe soeben im „Bollettino Inst. Entomol. Bologna" eine vorläufig monobasische neue Gattung *Alamira* beschrieben, deren typische Art *A. termitoxenizans* von Marquis S. PATRIZI, Rom, in einem Termitenbau bei Nairobi, Afrika, gefunden wurde. Das Tier ist halb Phoride, halb Termitoxeniide. Abgesehen von den Flügeln weist der Vorderkörper alle, aber auch alle Merkmale auf, die bisher als Sondergut der Termitoxeniidae galten: Abstehende Behaarung von Stirn, Thorax und Beinen, Schwund der feinen Grundbehaarung, Borsten auf dem Cerebrale, Mundteile mit labialen Stechborsten usw. Das Abdomen dagegen hat gar keine Ähnlichkeit mit dem einer Termitoxenie, es ist das Abdomen einer degenerierten und termitophil angepassten Phoride.

Die merkwürdigste Merkmalsmischung findet sich an den Flügeln. Es sind beim ersten Anblick scheinbar die Flügel einer etwas ungewöhnlichen Phoride. Denkt man sich aber die membranöse Flügelspreite weg, so hat man perfekt den Flügelstummel einer primitiven Termitoxenie, und zwar den der afrikanischen *Termitoscrofa pinguissima* Schmitz, mit all seinen rätselhaften Eigentümlichkeiten, die bisher bei den Phoriden ohne Beispiel dastanden.

Nachdem in der afrikanischen Gattung *Alamira* ein geradezu idealer Kollektivtypus aufgetaucht ist, scheint es mir taxonomisch geboten, die Termitoxeniinae neben die Alamirinae als Subfamilien zu den Phoriden zu stellen. Als Autor der Subfamilie Termitoxeniinae hat nach den Nomenklaturregeln WASMANN zu gelten, der auch selbst schon einmal von der „Subfamilie Termitoxeniinae" geredet hat, als er 1913 durch den Widerspruch so vieler Gegner vorübergehend schwankend geworden war.

Abb. 1. *Alamira termitoxenizans* Schmitz ♀, × 30. Kop. Boll. Inst. Entomol. Bologna, 1951.

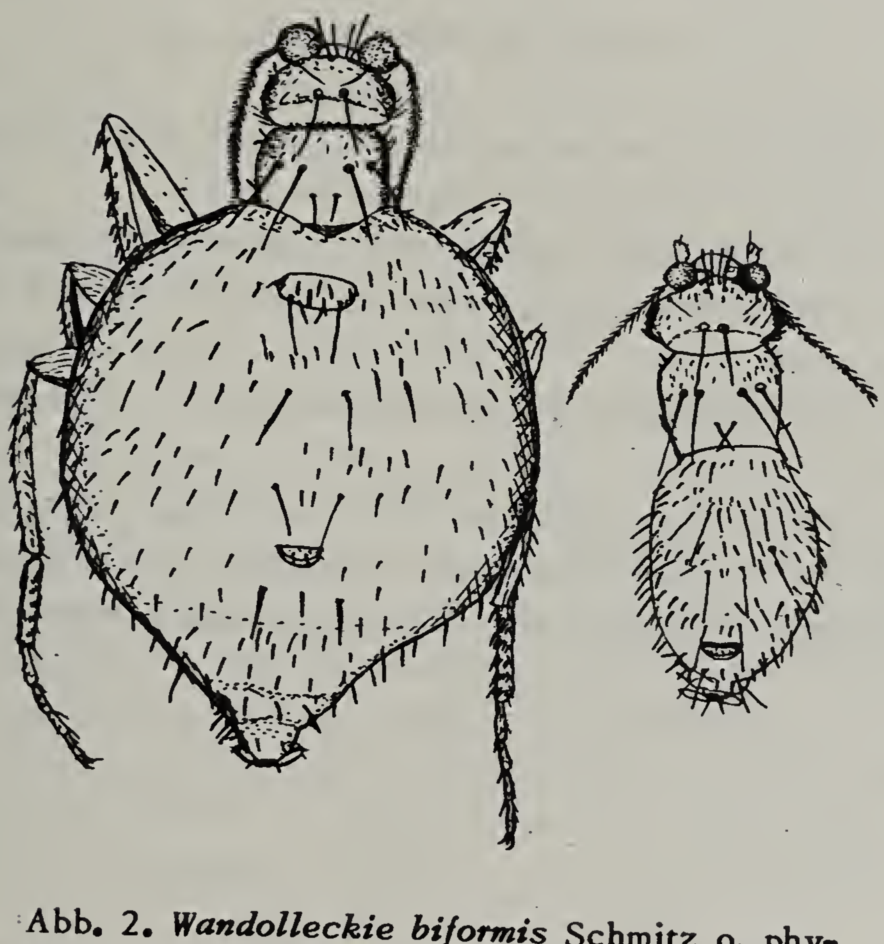

Abb. 2. *Wandolleckie biformis* Schmitz ♀, physogastres und stenogastres Stadium, × 42. Orig. Beine beider Stadien gleich, beim stenogastren weggelassen.

Als einzige Kennzeichen, die bisher von keiner Phoride bekannt sind, lässt sich nun nur noch der Ausfall des dritten Larvenstadiums, die starke Verlagerung der Endsegmente, der Hermaphroditismus und im Zusammenhang damit das Fehlen der ♂♂ und das Nacheinanderauftreten einer männlichen und weiblichen Phase anführen. Das genügt wohl nicht, um die Termitoxeniidae als Familie aufrecht zu erhalten. Es sind Merkmale, die fast ganz der Ontogenie, Anatomie und Physiologie angehören. Ferner sind diese Merkmale von den Phoriden bisher zwar nicht bekannt; ob sie aber dort nicht auch gelegentlich vorkommen, ist noch gar nicht abzusehn. Stenogastre und physogastre Imagines gibt es auch bei der afrikanischen Phoridengattung *Wandolleckia*, und es sind an der Universität Würzburg Untersuchungen eingeleitet um zu entscheiden, ob das auch in diesem Fall mit Hermaphroditismus zusammenhängt.

Die Tatsache, dass auch die Termitoxenien echte Phoriden sind, wirft auf die erstaunliche Plastizität der Phoriden ein neues Licht. Es gibt am Körper dieser kleinen Fliegen inwendig und auswendig kaum ein Organ, das nicht gelegentlich bei dieser oder jener Subfamilie, Gattung oder Art ganz exorbitante Wege der Entwicklung einschlüge. Wir hörten vorhin von P. Dr. BORGMEIER, dass diese Abänderungsfähigkeit selbst vor dem Gesetz der Pentamerie, dem alle anderen Dipteren unterworfen sind, nicht halt macht. Vor dem Gesetz der Getrenntgeschlechtlichkeit wird ebensowenig halt gemacht. Kurz, unter den vielgestaltigen Dipteren bilden die Phoriden ein Schöpfungswunder ganz eigener Art.

DISCUSSION

Mr. **Hering**: Finden sich Andeutungen am Flügel, dass dieser im Lauf des Lebens seinen hinteren Teil durch Abwerfen verliert?

Mr. **Schmitz**: Andeutungen wurden nicht beobachtet, aber ein späteres Abwerfen könnte möglich sein, dann würde die Ähnlichkeit mit den Termitoxenien noch grösser.

Mr. **Gouin**: Attire l'attention sur la nervulation de certains Chironomides (Corynoneura).

Mr. **Stammer**: Ganz analoge Proportions- und Organverlagerungen wie bei der Physogastrie der Termitoxeniiden kann man auch bei physogastren weiblichen Acarinen-adulti (Pyemotidae, Podapolipodidae) beobachten.

NOTE SUR LES CRYPTICUS APPARTENANT AU GROUPE DE C. VIATICUS FAIRM. (Col. Tenebrionidae)

par

F. ESPAÑOL C.

Barcelone, Espagne

Le groupe des *Crypticus* se rattachant à *C.viaticus* a été étudié par Mr. M.M.ESCALERA (1927) d'après des exemplaires gardés dans l'Institut Espagnol d'Entomologie à Madrid. Il a cru devoir faire de ce groupe une coupe nouvelle qu'il a appelé *Ulomoides*. Ultérieurement(1945) Mr.M. ANTOINE, dans son étude sur les *Crypticus* du Maroc, a completé la description du *punctatolineatus* Fairm., espèce qu'il a separé des autres *Crypticus* marocains pour en faire un groupe indépendant, mais sans lui accorder dénomination spéciale.

Or, les notes de ces auteurs restent incomplètes; celle d'ESCALERA parce qu'il a négligé l'éxamen de l'appareil copulateur masculin; celle d'ANTOINE parce qu'il s'occupe seulement de l'espèce marocaine.

Au cours de l'étude que j'ai pu faire du materiel paléarctique du groupe *Ulomoides*, constitué notamment par les collections de l'Institut Espagnol d'Entomologie de Madrid et du Musée des Sciences Naturelles de Barcelone, j'ai combiné la structure du pénis aux détails de morphologie deja réunis, chez ses insectes, par ESCALERA; de cette sorte je suis parvenu à la conclusion suivante: tout en retenant que les *Ulomoides* sont sans doute très voisins, par l'armure génitale mâle, des *Crypticus* s.str., *Crypticopsis* Ant. et *Seriscius* Motsch., il semble légitime, tenant compte de leur morphologie si particulière, de conserver cette section dans la nomenclature.

Toutefois le nom que lui a assigné ESCALERA n'est pas valable, car on connait depuis longtemps le genre *Ulomoides* établi par F.BLACKBURN pour un genre australien d'Ulomini. Je propose donc pour elle le nom de *Platycrypticus*.

Subgen. **Platycrypticus** nom. nov. (*Ulomoides* Esc.). Caracterisé par le corps ovale allongé, à côtés parallèles, deprimé au dessus et luisant; la coloration rouge brique ou brune, plus ou moins obscurcie, mais jamais entièrement noire; glabre ou couvert de petites soies hérissées peu denses et sans voiler les téguments. Tête à ponctuation forte, profonde et contigüe, bien plus forte que celle du corselet; antennes épaisses et assez longues. Corselet transversal, aussi large que les élytres, le maximum de largeur très près de la base, peu retréci vers l'avant en courbe régulière, les angles postérieurs peu obtus, presque rectes, jamais aigus, à peine courbés en dedans, mais avancés vers les épaules; les antérieurs très obtus, arrondis; impressions basales plus ou moins sensibles selon les exemplaires; dans le cas le plus favorable on en observe une sur les angles postérieurs, une autre, arrondie ou allongée, vis-à-vis de la 3e ou 4e strie des élytres, la

dernière, toujours allongée, placée au milieu. Elytres à stries bien creusées et grossièrement ponctuées; les points grands, arrondis et profonds. Premier article des protarses peu allongé, au plus, deux fois plus long que large, la face inférieure normalement conformée. Organe copulateur asymétrique, très évolué; les pièces latérales bien développées et toujours inégales; la pièce dorsale comprimée latéralement, à base élargie et bilobée.

Quoique très proche par le pénis aux *Crypticus* s.str., est bien distinct de ceux-ci par le corps legèrement aplati au dessus, à côtés parallèles, les antennes épaisses, la ponctuation forte et profonde de la tête, les stries, surtout les externes, bien creusées et toutes jalonnées de gros points.

Il s'écarte des *Crypticopsis*, outre les caractères ci-dessus indiqués, par le menton avec une fine carène longitudinale médiane, les métatarses plus courts que les tibias correspondants, et la partie terminale du canal éjaculateur soudée à la base de la pièce dorsale.

Le dessus glabre ou vêtu de courtes soies, peu denses et sans voiler les téguments l'éloigne d'ailleurs des *Seriscius* Motsch.

Tableau de determination

1.- Elytres glabres; antennes épaisses, à articles 4-7 peu plus longs que larges; pièce dorsale du pénis, vue latéralement, acuminée ou peu élargie à l'apex; les latérales aussi larges ou presque aussi larges que la dorsale, qui les dépasse à peine 2

2.- Protarses allongés, à premier article bien plus long que large, les 2e, 3e et 4e peu transversaux; partie basilaire du pénis anormalement élargie, partie apicale étroite et allongée; pièce latérale gauche en crochet à l'extremité; la dorsale comprimée en lame, aiguisée à l'apex . . . . *punctatolineatus* Fairm.

2'.- Protarses plus courts, à premier article peu plus long que large, les 2e, 3e et 4e plus transversaux, presque deux fois aussi larges que longs; partie basilaire du pénis de largeur normale; partie apicale élargie vers la base, proportionnellement plus courte; pièce latérale gauche autrement conformée; la dorsale comprimée en lame, élargie à l'apex 3

3.- Pronotum à ponctuation médiocre, mais assez forte et dense; celle des intervalles élytrales presque aussi forte et aussi dense que celle du pronotum; points des stries pas beaucoup plus grands que ceux des intervalles; partie apicale du pénis, vue latéralement, médiocrement élargie; pièce latérale gauche régulièrement arquée, peu élargie au milieu . *viaticus* Fairm.

3'.- Pronotum à ponctuation très fine et assez espacée; celle des intervalles encore plus fine que celle du corselet; points des stries notablement plus grands et plus profonds que ceux des intervalles; partie apicale du pénis, vue latéralement, plus large; pièce latérale gauche coudée et assez fortement élargie au milieu . . . . *viaticus* subsp. **pardoi** nov.

1'.- Elytres pubescents; antennes assez grêles, à articles 4-7 presque deux fois aussi longs que larges; pièce dorsale du pénis, vue latéralement, for-

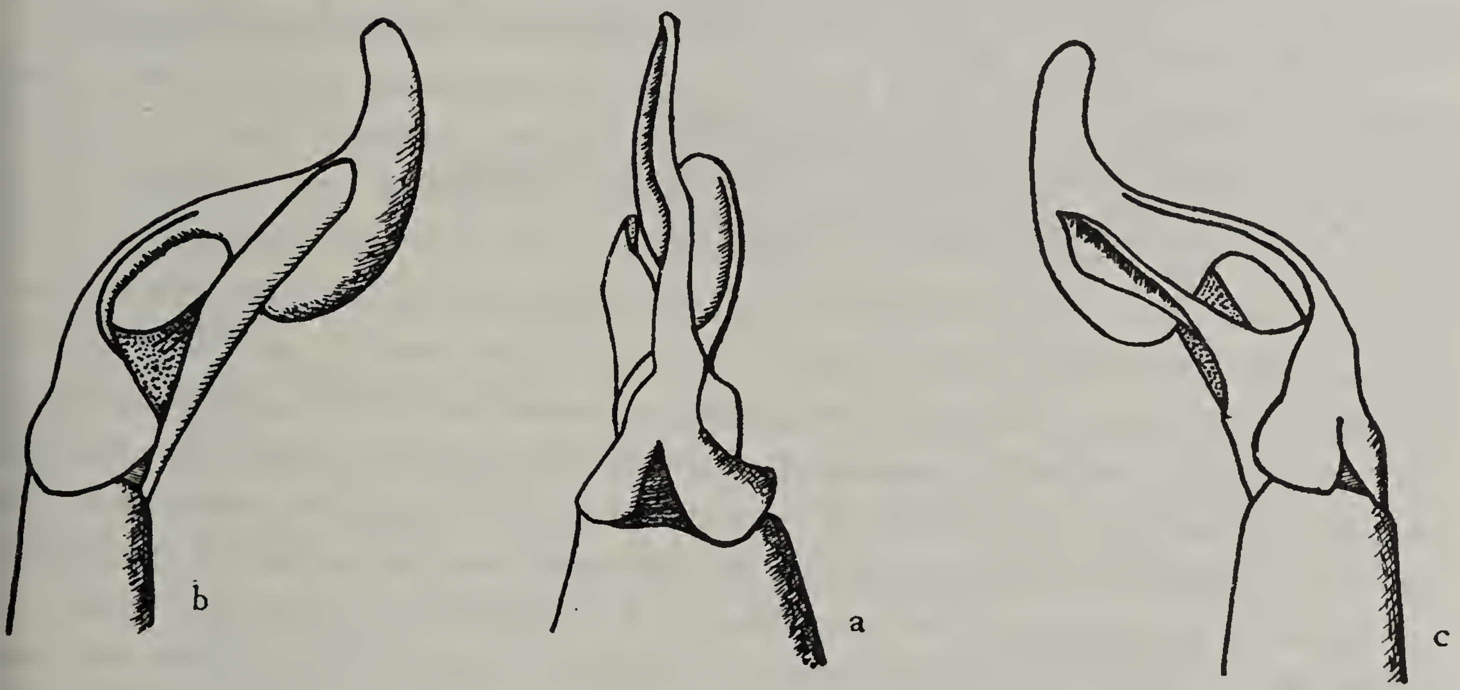

Fig. 1. Organe copulateur, profil gauche (région apicale): a, *C.(Platycrypticus) punctatolineatus* Fairm.; b, *C.(Platycrypticus) viaticus* Fairm.; c, id.id. subsp. *pardoi* nov. Fig. 2. *C.(Platycrypticus) frigidus* Esc.: a, apex de l'organe copulateur vue dorsale; b, le même, profil gauche; c, le même, profil droit.

tement et brusquement élargie avant l'apex, en lame sécuriforme; en sorte que les pièces latérales apparaissent bien plus étroites que la dorsale, dont l'extrémité les dépasse longuement . . . . *frigidus* Esc.

Crypticus(Platycrypticus) punctatolineatus Fairm. Maroc occidental. D'après ANTOINE c'est un insecte des terres fortes des régions basses ou de médiocre altitude: Chaouia, plaine de Ber-Réchid(Antoine); Fès(Fairmaire, type); El Kureimat(Escalera).

Crypticus(Platycrypticus) viaticus Fairm.(*ulomoides* Fairm.). Espèce assez largement répandue dans les régions, plutôt arides, d'Espagne centrale: Madrid(Mieg, Escalera); Vallecas, Alcalá de Henares, Villaviciosa de Odón, Balconete(Escalera); Cerro Negro, Madrid(Beltrán); Jetafe(Sans); Montarco(Bolivar); Cutamilla, Guadalajara(Bolivar); Quero, Toledo(Escalera); Santa Elena, Jaén(Escalera).

Subsp. **pardoi** nov.subsp. Trois exemplaires capturés par mon ami Mr. A.PARDO ALCAIDE, éminent spécialiste de Méloides, aux environs d'Aldea del Rey, Ciudad Real (Espagne centrale).

Crypticus(Platycrypticus) frigidus Esc. Andalousie: Baeza, Jaén(Escalera); Cañete de la Sierra, Serrania de Ronda, Málaga(Escalera).

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NUEVO AGDISTIS BETICO-MARROQUI
(Lep. Pterophoridae)

por

R. AGENJO
Madrid, España

Estudiando las genitalias de numerosos ejemplares de *Agdistis* como tarea preparatoria para la redacción de una Monografía sobre este género, tan mal conocido hasta ahora, tropecé con el de un ♂ de Yebel Tual, Ifni, en el Marruecos español, que en seguida separé como nueva especie. Posteriormente e insistiendo en mi labor de comprobación de las citas existentes en la literatura sobre *Agdistis*, señaladas de localidades españolas, conseguí, gracias a la amabilidad del Dr. PITTIONI, Kustos de Entomología en el Museo de Viena, y a la de mi amigo REISSER, el envio de dos ♂♂ y una ♀ que sirvieron a ZERNY para indicar *Agdistis staticis* Mill., como encontrada en Algericas, provincia de Cádiz. Las correspondientes disecciones anatómicas de este pequeño lote, demuestran que la especie de MILLIÈRE no fué correctamente indicada de Algeciras y que dicho material se refiere también a la nueva especie que describo a continuación.

Agdistis bifurcatus, nov. sp.

Holotipo ♂ de Yebel-Tual, en Ifni, Marruecos (Instituto Español de Entomología). Alotipo ♀ de Algeciras, en Cádiz, España (Museo de Viena).

♂. Cabeza cubierta de escamación gris-cenicienta. Frente algo abultada. Primer artejo de los palpos mayor que el 2^{o}; el 3^{o} es el más pequeño; los dos primeros son más claros. Entre el abultamiento frontal y el ápice de los palpos se produce una hendedura o muesca en cuya base, abarquillada hacia arriba y dilatada, se inicia la espiritrompa, que es larga y amarillenta. Antenas no pasando de los dos tercios de la longitud del ala; setáceas, de sección prismática, y color caramelo, con la cara dorsal cubierta por escamas cenicientoclaras, constituyendo una lámina que llega hasta el ápice de dicho apéndice. Abdomen y patas cubiertos de escamas grisáceas, salvo los primeros esternitos de aquel y la cara interna de estas, que son decisivamente más claras. Tibias anteriores aumentando paulatinamente de diámetro a partir del primer tercio de su longitud y terminando muy engrosadas a causa de estar revestidas con largas escamas castañogrisáceas, dirigidas de arriba hacia abajo. Primer artejo de los tarsos anteriores tan largo como los tres últimos reunidos y de mayor longitud que el 2^{o}; cada uno siempre más corto que el precedente. Metatarso blanquecino, mostrando en la cara anterior algunas escamas morenas que se hacen más abundantes en las proximidades de la inserción del 2^{o} artejo; éste todavía es claro, pero los tres últimos resultan oscuros. Tibias intermedias con un par de espolones apicales, de los cuales el externo es el más corto; tibias posteriores con un par de espolones

intermedios y otro de apicales, de iguales características que los antes descritos. Par de uñas de todas las patas bien desarrolladas.

Envergadura de 24 a 26 mm. Anverso de las alas anteriores grisnegruzco con débil tinte castaño, algunas escamitas gris-cenicientas y una zona triangular más clara castaño-morena limitada por los troncos de las venas *C*, *R* y el borde externo. En el ángulo interno de este triángulo se aprecia un punto negruzco formado por escamitas de dicho color. Sobre la *C* existen otras dos manchas negras, de las que la primera resulta equidistante entre aquellas. En algunos indivíduos se aprecia muy bien otra manchita análoga en el *tornus*. A veces, encuéntrase todavia otra manchita similar sobre *R*, igual a las tres ya indicadas antes, como visibles sobre *C*. Fimbrias morenas.

Anverso de las alas posteriores, de color castaño-moreno uniforme, que se hace algo más oscuro sobre el área anal.

Reverso de las alas anteriores castaño-moreno, muy aclarado hacia el ápice. Sobre la costa vense cuatro manchas negras casi equidistantes, salvo la más extensa, que se encuentra ubicada más cerca de la 3ª, que está en relación con la 2ª. En uno solo de los ejemplares estudiados, estas manchitas negras se observan también por el anverso, aunque aparecen allí menos destacadas a causa del fondo alar más oscuro.

Reverso de las posteriores como el de las anteriores, con el área anal cubierta de abundantes escamas y pelos que engruesan el ala. Sobre el tronco de $M_3 + C_{1a}$ y el de la C_{1b} se observan pequeñas espículas morenas, finamente alineadas, de las cuales las más próximas a la base del ala, están cubiertas por un alerón o abanico de escamas muy visible, incluso a simple vista.

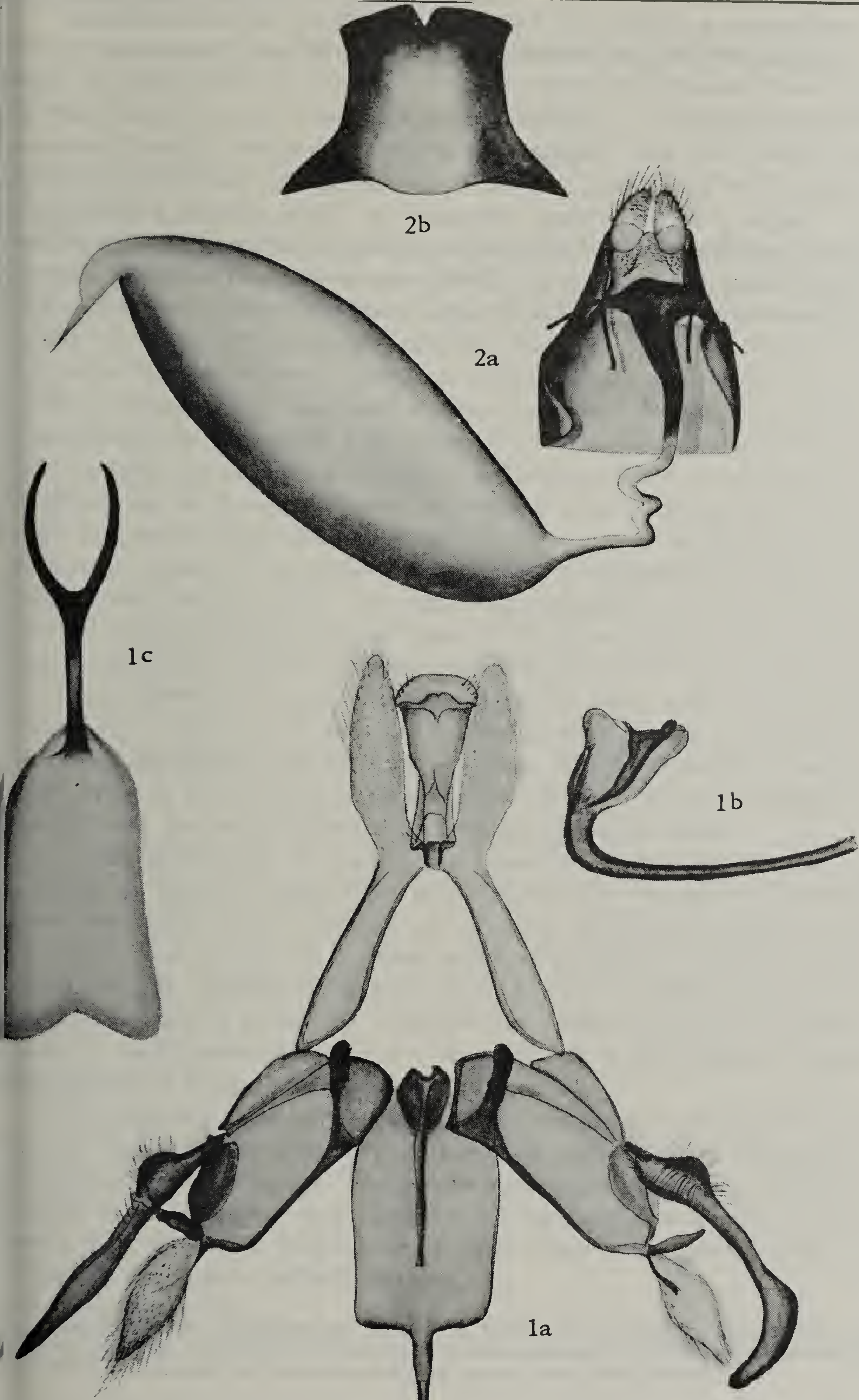
Andropigio. Del aspecto del de *sphinx* Wls. y *paralia* Z., pero divergiendo claramente por todos los detalles característicos de las distintas piezas. *Uncus* muy peculiar, protegido por dos delgadas lengüetas laterales, adornadas en el ápice con haces de largos pelos escamiformes. Valvas asimétricas. *Pseudoestilos* más fuertes y robustos que en *sphinx;* el izquierdo con su tercio medio adelgazado y el basal y distal engrosados, estando este último muy curvado. *Pseudoestilo derecho,* casi recto. Válvulas reducidísimas. *Cuiller* bien diferenciado y mucho menos desarrollado que en *sphinx*. *Aedeagus* como en la especie de WALSINGHAM, pero con el trayecto hasta la curvatura más delgado y quitinizado. *Sacculus* rectangular con una punta en el centro del borde distal.

VIII° esternito sumamente característico. Sobre el borde distal de una placa subpentagonal originase un apéndice bifurcado – inspirador del nombre para bautizar a la especie – que recuerda mucho a los bieldos de madera que se emplean en Castilla para las faenas de la trilla.

♀. Semejante, con 22 mm. de envergadura.

Ginopigio. *Ductus bursae* parecido al de *paralia,* pero con el *ostium* más adelantado hacia afuera. *Bursa copulatrix* grande, con *signum* poco quitinizado.

VIII° (+ VII°) esternito, subtrapezial, más largo que ancho, divergiendo mucho por lo tanto del de *paralia,* cuyo borde distal es muy bilobulado.



.1*a*-c. Andropigio de *Agdistis bifurcatus*, nov. sp. (preparacion 53774), Holotipo; *Aedeagus* del mismo; 1c.- VIII^{o} esternito del mismo. Fig.2*a*-*b*. Ginopigio de *:tis bifurcatus*, nov. sp. (Museo de Viena), Alotipo; 2*a*. (VIII^{o} + VII^{o}) esternito ıismo, 2*b*.- (VIII^{o} + VII^{o}), VI^{o}, V^{o} y IV^{o} terguitos del mismo.

VI° esternito subcuadrangular con aquel más corto que éste a causa de dos expansiones laterales; en *paralia* el VI° esternito es rectangular, de triple anchura que longitud. V° terguito muy característico, con la porción quitinizada reducida a una corta lámina, mas los bordes proximal y distal cóncavos.

Holotipo ♂ de Yebel-Tual, en Ifni, Marruecos español, jun. 1934 (F. Escalera leg.). Alotipo ♀ de Algeciras, provincia de Cádiz, España, 1-10 mayo 1925 (H. Zerny leg.). Paratipos, 2 ♂♂ adelfotípicos del Alotipo, capturados en mayo 1925 (K. Predota y H. Zerny leg.). El Holotipo en el Instituto Español de Entomologia de Madrid; el alo y los paratipos en el Museo de Viena.

NOTES SUR LE SYSTEME ACTUEL ET SUR LA POSITION SYSTEMATIQUE DES EUMOLPIDES (Col. Phytophaga)

par
JAN BECHYNE
Munich, Allemagne

Selon le „Zoological Record", le groupe des Chrysomeloidea est divisé en plusieures familles autonomes. Dans la plupart des ouvrages (surtout sur les faunes locales) on designe ces familles le plus souvent comme sousfamilles ou tribus d'une famille unique, celles des Chrysomelidae. Mais en fait elles possèdent des caractères propres d'une grande importance: caractères biologiques (Cassididae – Hispidae; Cryptocephalidae – Clytridae – Chlamisidae) et caractères morphologiques (Alticidae – Galerucidae). En ce qui concerne les groupes Eumolpidae – Chrysomelidae, le caractère le plus marquant est la forme de l'organe copulateur mâle. Celui-ci est très simple chez les vrais Chrysomélides; il présente un grand endosclérite principal dépassant souvent l'extrémité de l'oedeagus même pendant la rétraction totale du sac interne, tandis que celui des Eumolpides est composé de deux parties: l'une antérieure, représentant l'oedeagus stricto sensu (correspondant au pénis des vrais Chrysomélides mais qui a tous les sclérites petits) et l'autre postérieure, peu chitinisée, ayant la forme d'un tube qui ordinairement est beaucoup plus long que la partie antérieure *). Les autres caractères morphologiques qui séparent les deux familles (forme des tarses, des hanches et de la partie humérale des élytres) sont parfois peu remarquables, surtout chez les formes aberrantes (*Euryope*, *Jolivetia*, etc.).

La systématique de la famille des Eumolpides n'est pas encore connue. D'après les espèces américaines et malgaches (je n'ai pas eu l'occasion de faire des études plus poussées sur d'autres faunes) le système créé par CHAPUIS dans les „Genera Coleopterorum", et adopté par LEFÈVRE dans son „Catalogue des Eumolpides" (Mém.Soc.Liège [2] 11, 1885) semble être très artificiel quand on essaye de classifier les nombreux genres et espèces découverts ultérieurement. Voici une liste succincte des différents genres et des espèces à l'appui de cette idée.

1. Le caractère principal qui divise les Eumolpides en deux groupes devrait être la forme des épisternes prothoraciques (concaves ou convexes). Mais en réalité chez un groupe des genres malgaches (*Ivongius*, etc.) ils sont coupés en ligne droite, chez plusieurs *Colaspoides* américains ils sont concaves vers la saillie intercoxale et enfin chez le *Caryonoda* (genre américain) leur forme varie individuellement.

*) Dans l'ouvrage classique de SHARP & MUIR sur les organes copulateurs mâles, la figure (et les conclusions générales correspondantes) de l'*Eumolpus surinamensis* F. n'est pas exacte, le pénis étant figuré comme une seule pièce.

2. La forme des ongues est chez certains *Corynodes* orientaux variable individuellement; chez les *Colasposoma* malgaches elle ne représente qu'un caractère spécifique.

3. La forme des bords latéraux du prothorax devrait séparer les Colaspini (à côtés denticulés ou ondulés) des Iphimeini (à côtés mutiques). Mais ce caractère est, en réalité, très variable individuellement et il se répète successivement dans presque tous les groupes des Eumolpides (*Lepronida* dans Chrysodinini, *Wittmerita, Nodocolaspis, Nodonota* dans Iphimeini, *Otilea* dans Chalcophanini, *Phanaeta* dans Endocephalini). Au contraire, plusieures espèces des *Rhabdopterus* et *Alethaxius* (Colaspini) ont les côtés du prothorax sans aucune denticulation.

4. La forme du sommet de la saillie intercoxale du prosternum (prise pour séparer les Chalcophanini) se trouve également sous l'influence de la variabilité individuelle ou locale, ou très souvent, ce n'est qu'un caractère spécifique ou sousgénérique (*Ischyrolampra, Corysthea*); de plus il se retrouve également dans d'autres groupes des Eumolpides.

5. Question de la pubescence. Les formes glabres et pubescentes se trouvent presque dans toutes les tribus des Eumolpides. Beaucoup d'erreurs sont fondés sur le mauvais état des individus décrits (insectes déflorés).

6. L'échancrure des tibias (avant le sommet du bord externe) se répète dans un grand nombre des genres appartenant aux tribus diverses (*Balya* des Iphimeini, *Ruffoita* des Colaspini). Au contraire elle peut être absente chez les Typophorini (plusieurs genres malgaches) ou elle ne représente qu'un caractère sexuel (certaines espèces du genre *Colaspis*).

7. La forme de la partie subhumérale des élytres (vue latérale), simple, ou pliée chez les Chrysodinini, est un caractère tout à fait relatif, répété dans la plupart des familles des Coléoptères, offrant souvent des différences sexuelles (*Eucampylochira*).

8. La présence ou l'absence de l'épine fémorale est variable individuellement ou selon l'espèce (Typophorini) ou selon le genre (*Vianaeta*).

Il est donc évident que le système actuel ne peut pas être adopté et qu'il faut chercher à définir d'autres caractères. Il faut d'abord réviser les genres qui renferment des espèces semblables extérieurement mais en réalité sans affinités naturelles.

La littérature actuelle portant sur les Eumolpides offre bien peu de tableaux synoptiques et de figures, et bien peu d'indications biologiques. Et enfin bien rares sont les entomologistes qui s'occupent de ces insectes si intéressants et si peu connus.

DER WEIBLICHE GENITALAPPARAT DER GATTUNG TRECHUS (Col., Carabidae) UND SEINE BEDEUTUNG FUR DIE SYSTEMATIK

von

Harald SCHWEIGER

Wien, Österreich *)

Anlässlich einer Revision der subalpinen *Trechus*-arten der Ostalpen, konnte ich feststellen, dass sich die Weibchen vieler Arten bei der Verwendung der gebräuchlichen äusseren Merkmale nur sehr schwer unterscheiden liessen. Da aber gerade bei diesen Formen aus zoogeographischen Gründen eine exakte Definition der einzelnen Arten wünschenswert war, musste ich mich nach neuen systematischen Merkmalen umsehen. Ich leistete daher dem Ratschlag meines verehrten Lehrers Herrn Hofrat Dr. Karl HOLDHAUS, Wien gerne Folge den weiblichen Genitalapparat der Gattung *Trechus* Clairv. anatomisch genau zu untersuchen und auf seine systematische Verwendbarkeit hin zu überprüfen. Bei diesen Untersuchungen gelang es mir in der Folge – ähnlich wie seinerzeit HOLDHAUS bei der Gattung *Microlestes* und DE MONTE bei *Bembidion* – auch am weiblichen Kopulationsapparat artkonstante Merkmale nachzuweisen.

Bei der Untersuchung des weiblichen Kopulationsapparates wird das trockene Material zuerst in 2-5% Kalilauge mazeriert, was bei nicht zu alten Stücken durch vorsichtiges Aufkochen geschehen kann. Bei Verwendung von altem Material empfiehlt es sich jedoch dasselbe nur mit 2% kalter Kalilauge 24 Stunden lang zu behandeln, da damit die gleichen Resultate erziehlt werden. Nach erfolgter Mazeration lässt sich der weibliche Kopulationsapparat samt seinen chitinisierten Anhängen sehr leicht mit einer feinen Hakennadel aus dem Abdomen herausziehen. Zum weiteren Studium wird dann das Präparat in Kanadabalsam übergeführt. Bei der Untersuchung von lebendem Material geht man am zweckmässigsten folgendermassen vor. Das Tier wird zuerst mit Chloroform betäubt. Dann befestigt man es mit Hilfe eines erweichten Wachstropfens an einem hohlgeschliffenen Objektträger. Nunmehr lässt sich der Genitalapparat unter einem Tropfen physiologischer Kochsalzlösung sehr leicht heraussezieren. Es ist von Vorteil das Präparat vor dem Einschliessen in Kanadabalsam mit Boraxkarmin zu färben.

Am weiblichen Genitalapparat der Gattung *Trechus* finden sich systematisch verwertbare Unterschiede im Bau der Vagina, der Bursa copulatrix und des Eierganges **), während am Receptaculum seminis, welches hier von sehr hyaliner Beschaffenheit ist, den Ovarien und Ektadenien keinerlei Differenzen nachgewiesen werden konnten.

Die Vagina ist bei vielen Arten von dünner, hyaliner Beschaffenheit. Bei allen Arten deren Penis und Innensack durch scharfe Fortsätze oder absonderliche Form ausgezeichnet ist, zeigt jedoch die Vaginalwand die verschie-

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**) Bisher nur bei *Trechus alpicola* und *limacodes* Dej.

denartigsten Differenzierungen. Es können dann innerhalb derselben stärker chitinisierte Bezirke (*Tr. alpicola* Sturm., *splendens* Gemm. & Harold), Haftvorrichtungen (*Tr. constrictus* Schaum.) und dergleiche auftreten. Manchmal kommt es dabei auch zu einer taschenförmigen Ausstülpung der Dorsalwandung der Vagina, die als Bursa copulatrix bezeichnet wird und vermutlich zur Aufnahme der Penisspitze dient.

Diese Bursa copulatrix besitzt nun ganz hervorragende Merkmale zur Unterscheidung der einzelnen Arten. So finden z.B. bei *Tr. rotundipennis* Duft. einen langen, schlanken Penis (Fig. 1) mit einer relativ scharfen Spitze; die Bursa copulatrix ist bei dieser Art ebenfalls sehr lang und besitzt distal einige stark chitinisierte Bezirke (Fig. 2a). Bei *Tr. constrictus*, der ausser der langen Penisspitze auch eine kompliziert gestaltete Innensackauszeichnung aufweist, zeigt die Vagina drei sackartige Ausstülpungen mit stärker chitinisierten Bezirken, welche in sehr charakteristischer Weise angeordnet sind. Ähnliche Verhältnisse konnten auch bei vielen anderen Arten (*Tr. croaticus* Dej., *grandis* Gangib., *longicollis* Meixner u.s.w.) und bei *Duvalius exaratus* *) nachgewiesen werden.

Am Eiergang konnten bei *Tr. alpicola* und *limacodes* Dej. paarige, drüsige Anhänge beobachtet werden, die blindgeschlossen enden und in sehr charakteristischer Weise angeordnet sind (Fig. 2b). Über die Bedeutung dieser Anhänge konnte aber mangels lebenden Materiales bisher nichts genaueres in Erfahrung gebracht werden.

Durch anatomische Untersuchung des Kopulationsapparates dürfte es nunmehr möglich sein sämtliche schwierigen *Trechus*-arten auch im weiblichen Geschlechte sicher zu unterscheiden. Darüber hinaus kann aber auf Grund meiner Untersuchungen bei *Duvalius* angenommen werden, dass künftig auch bei vielen anderen *Trechini* eine sichere Unterscheidung der Weibchen nach der Form der Genitalorgane möglich sein wird.

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*) Der weibliche Kopulationsapparat der Gattung *Duvalius* weicht durch die weit nac vorne gerückte Bursa copulatrix sehr wesentlich von dem bei der Gattung *Trechi* beobachteten Bauplan ab. Diese Verhältnisse dürften bei dieser Gattung im Übe einstimmung mit den ausnehmend langen Penisformen entstanden sein.

Fig. 1. *Trechus rotundipennis* Duft. Penis (Profilansicht), 75 : 1.

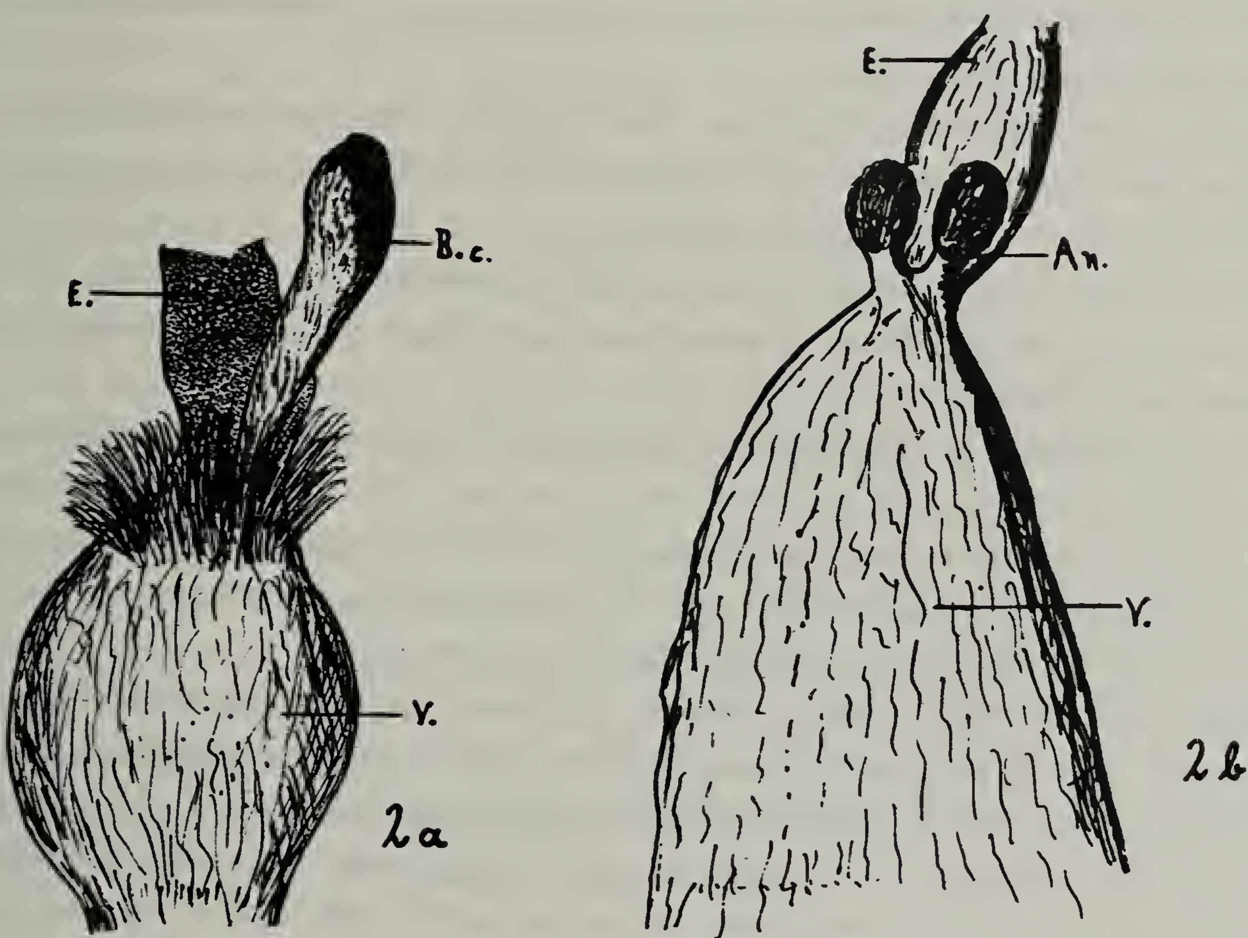


Fig. 2. Weiblicher Kopulationsapparat der Gattung *Trechus* (schematisch). 2a. *Tr. rotundipennis* Duft. V = Vagina, B.c. = Bursa copulatrix, E. = Eiergang; 2b. *Tr. limacodes* Dej. V = Vagina, An. = Anhänge des Eierganges, E = Eiergang.

EVOLUTION OF SEMINAL VESICLES IN ISOPTERA

by
C. JUCCI and A. SPRINGHETTI
Pavia, Italy

Many years ago one of us (JUCCI, 1924) described nurse cells of spermatozoids in the winged, swarming males of *Calotermes flavicollis* and *Reticulitermes lucifugus.*

It was observed at that occasion that at the stage of spermatogonia or the meiosis stage of spermatocytes, entire cysts of germinal cells stop their development, degenerate, descend through the vas deferens into the vesiculae seminales, accumulate there, desintegrate and melt into a sticky fluid, in which the spermatozoids of the termite king remain mobile.

JUCCI interpreted this peculiar feature as highly characteristic of termites, being an adaptation to the continuity of their sexual life, "la vita conjugale" of the royal couple, which forms the characteristic basis of the social life in Isoptera.

JUCCI suggested that a comparative histophysiological study of the sexual biology throughout the order Isoptera would be very interesting. He also ventured to say that cockroaches probably would show some rudiment of the condition that seems to have so efficiently promoted the development of the social life in termites.

As far as we know, in these thirty years, no one has followed up this suggestion. Consequently we took up this problem ourselves in the hope of collecting some additional information.

We choose for our study such archaic termites as *Termopsis* and *Mastotermes,* and compared their condition with that in the Blattoids, as *Periplaneta* and *Blattella.*

The condition in the black cockroach, *P. orientalis*, is well-known. The big seminal vesicle is covered with the utriculi of the mushroom-shaped gland. Some of these utriculi being situated in peculiar positions appear to be filled with spermatozoids, and to serve as true reservoirs. It is a condition very dissimilar from that found in *Calotermes.*

Now in *Termopsis angusticollis* [1] some intermediate condition can be observed: a big, ellipsoidal seminal vesicle is present which is crowned by glandular digitations branching from two tubes rising out of the caphalic pole of the vesicle. As compared with *Periplaneta* drastic reduction of the glandular area has taken place, together with obliteration of the sperm reservoirs. But the secretion of the utriculi is still active which is especially evident in the dealated stage of the adult. This secretion is entirely absent in the soldiers.

1) Dr. KIRBY, of Berkeley, California, very kindly provided us with many specimens of this species.

We had no opportunity for studying of *Archotermopsis*, the most archaic of the Termopsine subfamily; but from the studies of IMMS we know that the condition of that genus in comparison with *Termopsis* is just a step nearer to that in *Periplaneta.*

Mastotermes darwiniensis, the last survivor of the most ancient family of the Isoptera, possesses a "cauliflower" of glandular digitations covering the cephalic pole of the vesicle. These digitations are sessile, that is to say, not branching from two stems, but rising directly from the concamerations of the ellipsoidal seminal vesicle.

Evidently there exists the following evolutionary series of the structure of the seminal vesicle: Blattoidea, *Mastotermes, Archotermopsis, Termopsis, Calotermes.*

But what about the nurse cells? In *Mastotermes* already they can be found in a quite typical condition, easily recognizable because of their picnotic and acidophilic nuclei, and for their aspect of desintegration.

They do not, however, occur in such a number as in *Calotermes*; and the fluid that fills the concamerations of the seminal vesicle evidently is from two different sources: originating through the excretive activity of the glandular utriculi, and by the degeneration of the "nurse cells".

One might be surprised by such an early provision with nurse cells, in such an archaic from as *Mastotermes,* but we do not think this at all strange.

If the purpose of the nurse cells is only that of providing for an adequate nucleic nourishment to the spermatozoids – as an adaptation to the sexual life of the royal couple, and to the needs of the social life – this old genus must be in possession of nurse cells, since we find in *Mastotermes* quite an advanced organization of society. Its condition is a compromise between the needs of physiological adaptation, that could be relatively quick, and the possibilities of anatomical structure, that is bound to be much more conservative. Also we must bear in mind that *Mastotermes* – at present confined to Australia, but once inhabiting a large area, including Europe and North America – has had a very long period of time for evolution, viz. from eocene to our days.

It is our intention to deepen the comparative study of seminal vesicles throughout Isoptera. It seems to be very interesting to make a discrimination between the effects of adaptation to a peculiar sex biology and social organization on one hand, and on the other, the effects of the level of organization corresponding with the phylogenetical stage. Because in this competitive cooperation of form and function in evolution lies the most fascinating problem that life offers to our scientific curiosity.

DISCUSSION

Mr. **Noirot**: Avez-vous eu l'occasion d'étudier les Termites superieures?

Mr. **Jucci**: I did not study the higher Termites yet. According to HOLMGREN and other authors some of these Termites at least must have reduced seminal vesicles. Pe:haps the adaptation that already began in *Mastotermes*, culminated in *Calotermes*, and is still present in *Reticulotermes* (with some modifications, however, like the formation of spermatophores), is changed in Metatermitidae; this change possibly is in correlation with the continuity of the spermatogenesis throughout the year, in countries with a tropical climate.

I am certain that a comparative anatomical study throughout the Isoptera would be very useful for a better understanding of sexual behaviour and of organisation in the higher Termites.

ON THE MAJOR CLASSIFICATION OF THE MIRIDAE (Hemiptera, Heteroptera)

by

J.C.M. CARVALHO

Rio de Janeiro, Brazil

Summary

Since REUTER's classification (1910) of this family into subfamilies and divisions (tribes), many new genera and species have been described from different regions of the world. The technique of study has also been improved and the genitalia taken into consideration. There is consequently urgent need of a revision of the Reuterian system, which has been followed by most European workers and, with some modifications, by hemipterists from other continents.

The new system here proposed is based mainly on the same characters as those used by REUTER and his predecessors, namely the type of arolia and structure of the claws, presence or absence of a pronotal collar, structure of tarsi and membrane, ostiolar peritreme and myrmecomorphic aspect. The genitalia are also considered, specially the male penis. Other minor characters have also been taken into consideration.

The 9 subfamilies established by REUTER and the 11 accepted by American authors are here reduced to six subfamilies. Of the 23 divisions (tribes) erected by REUTER and the 32 used by recent workers, the present system accepts only 24, including two new ones and the Termatophylini which REUTER regarded as a family distinct from the Miridae.

The following subfamilies are considered: Mirinae, Orthotylinae, Phylinae, Bryocorinae, Deraeocorinae and Cyclapinae. The tribes under each subfamily are as follows: Mirinae (Mecistoscelini, Pithanini, Stenodemini, Herdoniini, Capsodini, Hyalopeplini and Mirini); Orthotylinae (Halticini, Pilophorini and Orthotylini); Phylinae (Hallodapini, Dicyphini and Phylini); Bryocorinae (Bryocorini, Monaloniini and Odoniellini); Deraeocorinae (Termatophylini, Clivinemini, Hyaliodini, Saturniomirini and Deraeocorini); and Cylapinae (Fulviini, Dashymeniini and Cylapini).

Keys are given for the subfamilies and tribes.

The need to follow the International Rules of Zoological Nomenclature have obliged the author to drop names previously used in the past in favour of others which are thought to be the correct ones, as explained in each case.

The author shares the opinion of past workers that the claws and the arolia are still the best characters to be used in the subdivision of the family into subfamilies and tribes. This opinion is further corroborated by the structure of the male penis and the female genitalia, as recently shown by J.S.SLATER (1950). The type of pronotal collar, number of cells in mem-

brane, structure of tarsi, ostiolar peritreme and structure of the hemielytra also give valuable help as secondary characters.

The genitalia alone have been found to be misleading in some instances and their acceptance as the major character would certainly cause changes in the present classification. The author feels however that much more study is still needed on this matter before a new classification can be proposed.

At present, the author has found that the actual characters now used, are perfectly safe and workable for the division of the family into natural groups. It is his opinion that classifications are made to render the study of a definite group easier and accessible to the average entomologist rather than as the exclusive property of the specialist. They must be practical above all and only by being so can they be already accepted and used.

The family Miridae has increased considerably during the recent years, the actual total number of genera known being 750, although no less than 270 genera previously established have been reduced in synonymy.

The distribution of genera in the various tribes is as follows: Fulviini (19); Dashymeniini (5); Cylapini (12); Termatophylini (4); Clivinemini (10); Hyaliodini (14); Saturniomirini (3); Deraeocorini (22); Bryocorini (68); Monaloniini (14); Odoniellini (17); Phylini (124); Hallodapini (38); Dicyphini (24); Halticini (23); Orthotylini (74); Pilophorini (28); Mecistoscelini (2); Stenodemini (24); Pithanini (3); Mirini (174); Hyalopeplini (16); Capsodini (14); Herdoniini (18).

BAU UND FUNKTION DER MUNDWERKZEUGE BEI DEN HELODIDEN-LARVEN (Col.)

von

M. BEIER
Wien, Österreich

Schon an anderer Stelle (BEIER, Eos Madrid, Vol. 25, 1949, p. 49-100) wurde an *Helodes hausmanni* Gredler gezeigt, dass der Bau der Mundwerkzeuge der Helodiden-Larven ausserordentlich kompliziert ist und innerhalb der gesamten Coleopteren kein Gegenstück findet. Die Mundwerkzeuge wirken hier als automatischer Sammelapparat feiner Sinkstoffe (Detritus), die von submersen Steinen oder Pflanzenteilen abgekehrt, im Munde gefiltert und gepresst und schliesslich als kompakte Klümpchen verschluckt werden. Man kann bei diesem ganzen Vorgange vier Funktionsphasen unterscheiden, wobei die 1. und 3. sowie die 2. und 4. Phase zeitlich zusammenfallen, so dass die Mundwerkzeuge bei der Nahrungsaufnahme und -verarbeitung im Zweitaktrhythmus arbeiten. Kurz zusammengefasst, lässt sich dies folgendermassen darstellen:

1. Phase: *Einholen der Nahrung durch die Maxillen.* Der flache Kopf liegt der Unterlage auf; die mit einem dichten Schopf am Ende kammförmig gezähnter Borsten versehenen Maxillen werden seitlich ausgeschwungen, an das Substrat gepresst und dann unter rollend-schürfender Bewegung wieder eingezogen, wobei sich ihre Borsten mit den Sinkstoffen beladen. Eine Auswahl der brauchbaren Nahrungspartikel erfolgt hierbei nicht, doch können grössere und schwerere Partikel, wie Sandkörner, von den Maxillen nicht erfasst werden.

2. Phase: *Übernahme der Nahrungspartikel durch den Sammelapparat der Mundwerkzeuge.* Durch Senken des in der ersten Phase gehobenen Clypeolabrum werden die Maxillen gegen den sich mit dem Labium vorschiebenden grossen, kompliziert gebauten Hypopharynx gepresst und von dessen Krallenapparat sowie von den mit feinen Zähnchenreihen ausgestatteten Seitenloben der Superlinguae ausgekämmt. Die sich schliessenden Mandibeln die in der ersten Phase geöffnet waren, kehren mit den langen Fiederborsten ihres Medialrandes die Nahrungspartikel nach einwärts und hinten, so dass sich diese in der zwischen dem Krallenapparat und den Kammplatten des Hypopharynx schräg mediokaudalwärts verlaufenden Rinne als bereits ziemlich wasserarmer Nahrungsbrei sammeln.

3. Phase: *Beförderung der Nahrung zum Mahlraum.* Während die Maxillen neuerlich zur ersten Phase ausgeschwungen, das Clypeolabrum gehoben und das Labium mit dem Hypopharynx ruckartig zurückgezogen werden, wird der hintere Teil der Präoralhöhle durch Kontraktion der Hypopharynxmuskeln und dadurch bedingtem Senken des Hypopharynxbodens erweitert. Hierdurch wird der Nahrungsbrei in den erwähnten Schrägrinnen und über die mit mediokau-

dalwärts streichenden Börstchenreihen versehenen Kammplattenstiele nach hinten gesaugt und staut sich an einem durch die Senkung des Hypopharynxbodens steil aufgerichteten hypopharyngealen Borstenfeld vor dem Mahlraum, wo er auch mit Speichel versetzt wird.

4. Phase: *Aufbereitung der Nahrung im Mahlraum.* Indem Maxillen, Mandibeln und Labium neuerlich die in der zweiten Phase geschilderten Bewegungen ausführen, gleitet der Nahrungsbrei in den stark chitinisierten Mahlraum und wird hier zwischen Zahnplatten und Mittelkeil des hypopharyngealen Pressapparates einerseits, dem Zapfen des Epipharynx anderseits und den Molaren der Mandibeln zusammengepresst, entwässert und zerrieben. Währenddessen ist der Mahlraum gegen den vorderen Teil der Präoralhöhle durch den wieder gehobenen Pharynxboden und das Anschmiegen dessen Polsters an das Borstenfeld des Epipharynx hermetisch abgeschlossen, so dass dort die Vorgänge der zweiten Phase sich wiederholen können. Wird nun der Mahlraum zum Ansaugen frischen Nahrungsbreies (Phase 3) wieder erweitert, so gleitet das kompakte Klümpchen aufbereiteter Nahrung aus ihm nach hinten in die Oralhöhle. Dort sammeln sich, da die Larve in der Minute etwa 70 bis 80mal Nahrung einholt, in kurzer Zeit mehrere solcher Klümpchen an, die dann partieweise durch die Pharynxpumpe in den Ösophagus gesaugt werden.

Aus dem Gesagten ist ersichtlich, dass der Hypopharynx der wichtigste und komplizierteste Bestandteil des Nahrungsaufnahmeapparates der Larve ist. Sein Feinbau weist nicht nur artspezifische, auch für systematische Zwecke gut verwertbarer Differenzierungen auf, sondern lässt vielfach auch offenkundig durch die Besonderheiten des Biotops bedingte Modifikationen erkennen, wenn auch sein allgemeiner Bauplan und seine Funktionsweise innerhalb der ganzen Familie stets prinzipiell dieselben sind. So ist zum Beispiel sein Filterapparat, also Kammplattenzähne, Krallenapparat und Zähnelung der Seitenloben der Superlinguae, ebenso wie sein Pressapparat (Zahnplatten und Mittelkeil) bei den vorwiegend in rasch fliessenden kleinen Quellbächlein mit gröberen Sinkstoffen lebenden *Helodes*-Larven (*H. hausmanni* Gredler und *H. marginata* F.) wesentlich derber gebaut als bei den in der ruhigen Uferströmung grösserer Bäche sich aufhaltenden Larven von *Hydrocyphon deflexicollis* Mull., denen Sinkstoffe von weit feinerem Korn als Nahrung zur Verfügung stehen (vergl. Fig. 1 und 2). Artspezifische Unterschiede sind im Hypopharynx vor allem die Zahl der Kammzähne, deren zum Beispiel *Helodes hausmanni* Gredler 12, *H. marginata* F. 8 + 4 kleine und *H. minuta* L. 10 besitzen, die Zahl der sich bei *Helodes* proximal an die Kammzähne anschliessenden Krallenzähne – bei H. *hausmanni* 7 bis 9, bei *H. marginata* 6 und bei *H. minuta* 5 – sowie die Ausgestaltung des Krallenapparates. Ein charakteristischer generischer Unterschied zwischen *Helodes* und *Hydrocyphon* ist neben den äusseren Merkmalen das Fehlen der proximalen Krallenzähne an den Kammplatten bei der letztgenannten Gattung. Eine geringe individuelle Variabilität in der Anzahl der Kammzähne konnte nur bei *Hydrocyphon deflexicollis* beobachtet werden, wo sie zwischen 14 und 1

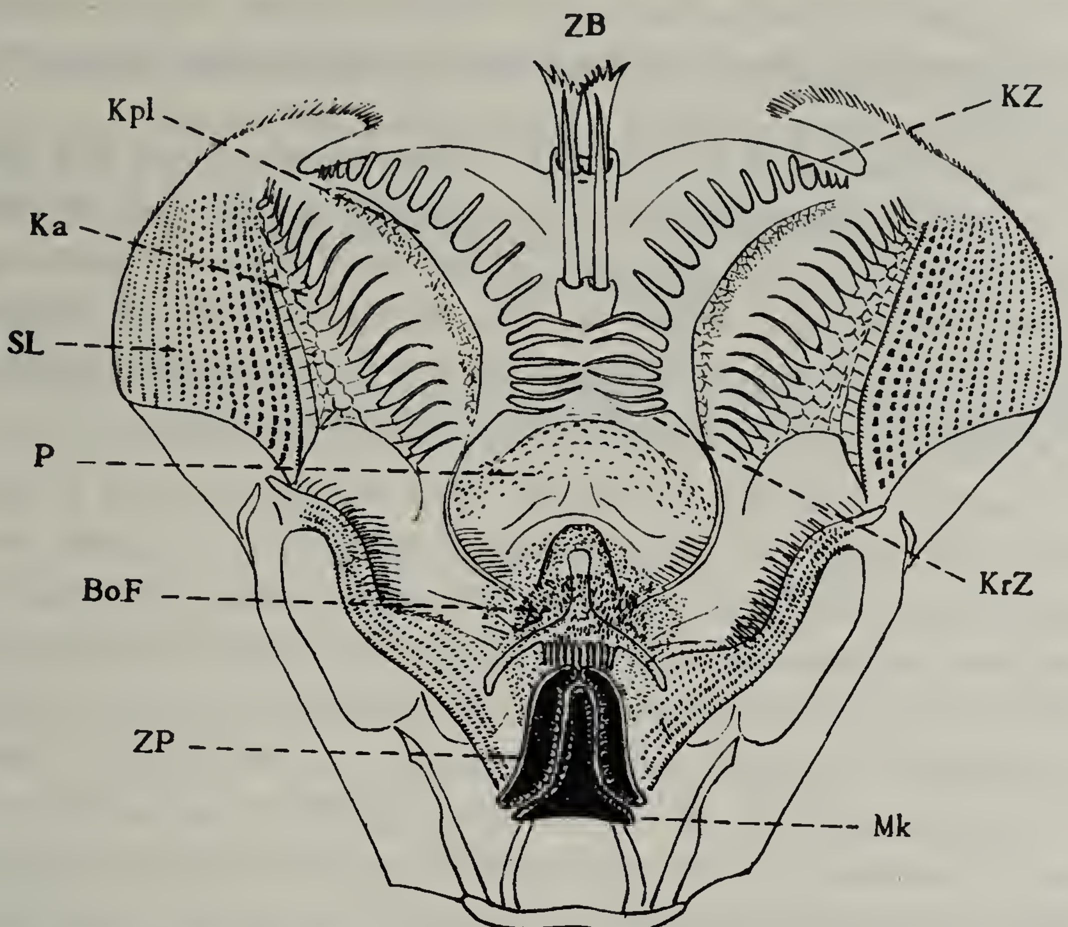


Fig. 1. Hypopharynx der Larve von *Helodes marginata* F. (Lunz, Quellbächlein in der Öd am Flözersteig).

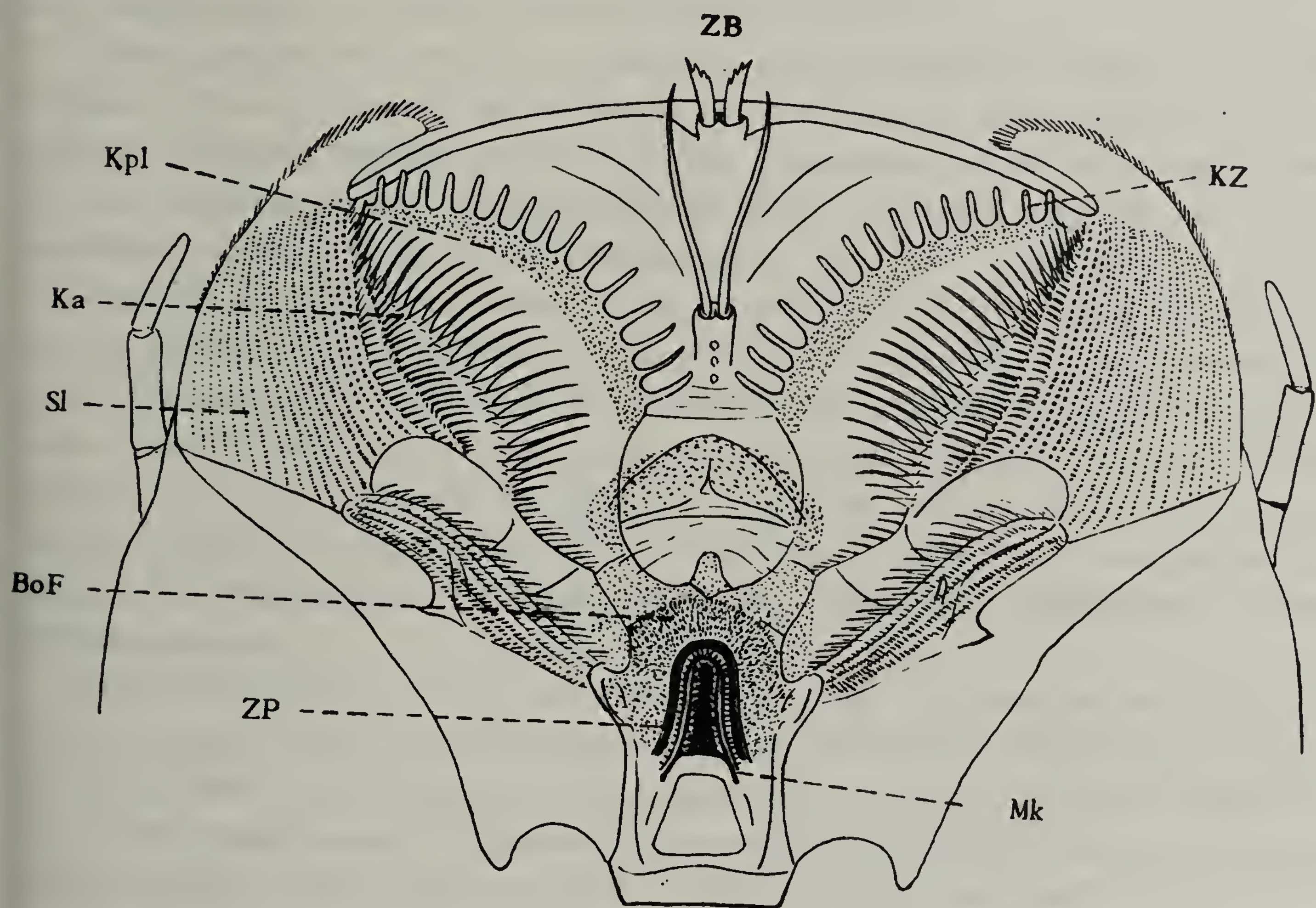


Fig. 2. Hypopharynx der Larve von *Hydrocyphon deflexicollis* Müll. in seiner natürlichen Lage auf dem Labium (Lunz, Unterer Seebach). Erklärung der Abkürzungen für beide Figuren: BoF = Borstenfeld, Ka = Krallenapparat, Kpl = Kammplatte, KrZ = Krallenzähne der Kammplatte, KZ = Kammplattenzähne, Mk = Mittelkeil des Pressapparates, P = Polster, Sl = Seitenloben der Superlinguae, ZB = Zahnborstenpaar, ZP = Zahnplatte des Pressapparates.

schwankt. Es scheint jedoch, dass auch diese Zahlen nicht innerhalb einer Population variieren und somit möglicherweise durch die Eigenart des Biotops bedingt sind.

Diese gedrängte Übersicht soll nur die Aufmerksamkeit auf den bisher kaum beachteten, in funktionsmorphologischer Hinsicht jedoch sehr bemerkenswerten Bau der Mundwerkzeuge bei den Helodiden-Larven lenken und unsere Kenntnisse darüber auf eine etwas breitere Basis stellen. Im übrigen sei auf die eingangs zitierte Arbeit verwiesen, in der die morphologischen Verhältnisse bei *Helodes hausmanni* ausführlich dargestellt sind.

NOTE PRELEMINAIRE SUR LA CLASSIFICATION DES COLEOPTERES CERAMBYCIDES

par

P.LEPESME et St. BREUNING

Paris, France

Nul ne saurait nier que la classification actuelle des Coléoptères de la famille des *Cerambycidae*, avec ses quelques 37.000 espèces décrites à ce jour, laisse à désirer. Si les Prioniens, tels que les a définis LAMEERE, forment un groupe à peu près homogène, en en séparant toutefois, avec PAULIAN et VILLIERS *), les Parandrines et probablement aussi un certain nombre d'Anacolines, et si les Lamiens constituent une véritable "entité", il n'en est pas de même des Cérambyciens dont on a déjà isolé les Disteniinae, Lepturinae et Aseminae sans pouvoir d'ailleurs en donner toujours de définition à l'état „imaginal", ni de limites nettes.

La nervation alaire et la morphologie larvaire demeurent à la base de la classification; un caractère, à lui seul ainsément utilisable, permet d'isoler les Lamiens = Lamiinae d'AURIVILLIUS in JUNK *Coléopterorum Catalogus*, Lamiidae du *Zoological Record*, Lamiaires de BREUNING qui en a révisé une grande partie au cours de ces dernières années :

Tibias antérieurs coudés et plus ou moins échancrés dans leur région distale, celle-ci faisant une rotation sur son axe de telle sorte que la face latérale externe, limitée dans la région proximale par le bord supérieur et le bord inféro-externe, devient limitée dans la région distale par le bord supérieur, courbé, et le bord inféro-interne.

C'est là un caractère constant qui ne prête pas à confusion comme c'est le cas parfois pour l'inclinaison du front sur le vertex. La concordance de ces deux caractères **) avec la nervation alaire et la morphologie larvaire nous incite à séparer complètement les Lamiinae de tous les autres Cerambycidae et, pour éviter de les élever au rang de famille, à grouper tous ces derniers dans la sous-famille des Cerambycinae sensu novo comprenant les supertribus **Parandrina, Prionina, Asemina, Lepturina, Disteniina** et **Cerambycina** nom. nov.

C'est l'ensemble de ces caractères qui nous fait exclure des Lamiinae pour le ranger dans les Cerambycinae le *Polyacanthia tigrina* Fauv. classé jusqu'ici dans les Velorini; nous proposons de créer pour cette espèce le genre **Neclamia**, *nov.*, le genre *Polyacanthia* demeurant dans les Lamiens avec les deux espèces *Fonscolombei* Montr. et *trifolium* Fauv.

Il en est de même du genre *Toxotomimus* Hell. avec l'unique espèce *diopetes* Hell., rangé jusqu'ici dans les Enicodini, qui doit passer dans les Cerambycinae. Les deux espèces *baladica* Montr. et *fasciolata* Fauv., clas-

*) Rev. fr. Ent. 8 : 202, 1941.

**) Le caractère utilisé par LACORDAIRE et répété depuis par les auteurs du „dernier article des palpes aciculé" s'avère inutilisable.

sées dans le genre *Zygocera* (Zygocerini) viennent également s'inclure dans le genre *Toxotomimus*. Mais *baladica* Montr., 1861, n'est qu'un synonyme de *Toxotomimus diopetes* Hell., 1917, et devient donc le type de ce genre. On a en définitive, dans les Cerambycinae, avec une position qui reste à préciser, le genre *Toxotomimus* Hell. comprenant deux espèces :

Toxotomimus baladicus, *nov. comb.*
= *Zygocera baladica* Montr., 1861
= *Toxotomimus diopetes* Hell., 1917

Toxotomimus fasciolatus, *nov. comb.*
= *Zygocera fasciolata* Fauv., 1906

Comme dans toute classification,il existe malheureusement des formes transitoires difficiles à interpréter.Ainsi l'Oemini *Auxesis gabonica* Thoms., que l'un de nous croyait pouvoir ranger dans les Lamiaires*) de par ses tibias antérieurs du type „lamiaire", présente une nervation alaire du type „cerambyciaire" alors que le genre voisin *Paranxesis* avec *P. cicatricosa* Auriv. n'offre qu'une ébauche d'échancrure et de „version" des tibias antérieurs, tout en présentant le même type alaire. Il est certain que ces deux genres, auxquels il faut ajouter les genres *Psathyrus* Thoms., *Combesius* Lep., *Psathyrissa* Auriv. et probablement d autres, doivent être séparés des Oemini proprement dits et rangés dans un même groupe de transition qui, bien qu'offrant d'incontestables affinités avec les Lamiinae, n'en reste pas moins à conserver dans les Cerambycinae et pour lequel nous proposons de créer la supertribu des **Auxesina** avec pour type: *Auxesis gabonica* Thoms.

Chez les Prionina ou Prioniens (Prioninae d'AURIVILLIUS, Prionidae du *Zool.Rec.*), la présence ou l'absence d'un rebord latéral séparant nettement le disque du pronotum des côtés ne concorde pas toujours, loin s'en faut, avec la nervation alaire et la morphologie larvaire et, si l'on faisait abstraction de ces caractères, bien des genres s'apparenteraient aux Cerambycinae, *Megopis* par exemple.

Signalons à propos des *Megopis* que seuls les *Baralipton maculosum* Thoms., *Severini* Lmr. (et probablement *Dohrni* Lmr. classé par cet auteur dans le même sous-groupe) présentent, à notre connaissance, un véritable rebord latéral au pronotum. Ce caractère, joint à la présence d'une épine aigüe à l'angle apical interne du scape antennaire, nous incite à exclure du sous-genre *Baralipton* toutes les espèces que LAMEERE y avait englobées: *mandibularis* Frm., *marginalis* Frm., *bicoloripes* Rits., *Lansbergei* Lmr., *granulifera* Lansb., *fimbriata* Lansb., *metallica* Auriv., *Gahani* Lmr., *Kolleri* Lmr., *costata* Lansb., *reflexa* Karsch et *cingalensis* White et à rendre à *Baralipton* la position de genre que THOMSON lui avait donnée.

Nous proposons de grouper les espèces exclues, lesquelles restent des *Megopis*, dans le sous-genre **Megobaralipton**, nov. sbgen., caractérisé par un pronotum sans véritable rebord latéral et des antennes frangées en dessous

*) Bull. Inst. R. Sc. Nat. Belgique, 25, n° 38: 13, déc. 1949.

chez le ♂, ce dernier caractère n'existant pas dans les autres sous-genres.

Les Asemina et Lepturina (Aseminae et Lepturinae auct.) ont été définis par les auteurs de par leurs caractères alaires et larvaires. Il est vraiment regrettable qu'aucun autre caractère ne permette actuellement de les séparer à l'état imaginal, tant entre eux, que des sous-familles voisines. La question est à reprendre.

Les „Cérambycides" tels que les a définis LACORDAIRE (Cerambycinae d'AURIVILLIUS) sont caractérisés par „le dernier article des palpes non aciculé, les jambes antérieures sans sillon oblique interne, la languette en général membraneuse; le pronotum très rarement distinct des flancs du prothorax et les hanches antérieures très variables".

Une fois même isolés les Asemina, Lepturina et Disteniina, ces caractères ne permettent pas de voir dans les Cerambycina un groupe naturel. Seule une étude très approfondie permettra de les définir vraiment. La question est de préciser les caractères offrant, en l'occurence, une valeur réelle.

A notre avis, deux caractères seulement, la nervation alaire et l'insertion des antennes permettent de les séparer des Asemina, Lepturina et Disteniina. De même deux caractères seulement nous paraissent également à retenir pour diviser la sous-famille: les yeux grossièrement ou finement facettés et les cavités coxales intermédiaires ouvertes ou fermées.

L'ouverture des cavités coxales antérieures employée d'une manière générale par LACORDAIRE et les auteurs qui n'ont fait que le suivre, ne peut nullement servir à découper la sous-famille en tribus.

Pour n'en citer qu'un exemple, les Callichromides, tribu homogène, groupent, contrairement à ce que dit LACORDAIRE, presque autant de genres à cavités coxales antérieures largement ouvertes en arrière que de genres à cavités fermées et l'on observe même les deux cas à l'intérieur de certains genres, tels que *Hospes*.

L'élargissement transversal de la saillie prosternale en arrière des hanches, élargissement qui ne correspond pas toujours à la fermeture des cavités coxales, a probablement plus de valeur. Nous croyons pouvoir également attacher une certaine importance aux hanches antérieures fortement transverses, du type prionien, que l'on observe chez certains Cerambycini, chez les Tornentini, chez les Plectogaster, en précisant qu'il ne faut confondre en aucune façon ce type de hanches avec les „hanches anguleuses en dehors", c'est-à-dire arrondies, mais offrant au côté externe une saillie aigüe toujours courte, par opposition aux hanches „globuleuses", c'est-à-dire régulièrement arrondies et sans saillie, caractère utilisé fréquemment par les auteurs.

En résumé, en attendant que l'examen d'un très grand nombre de formes nous permette de la préciser davantage, nous proposons pour les *Cérambycidae* la classification suivante:

Subfam. CERAMBYCINAE. sensu novo

Supertribu *Parandrina*, nov. nom.

„ *Prionina*, nov. nom.

Supertribu *Asemina*, nov. nom.
" *Lepturina*, nov. nom.
" *Disteniina*, nov. nom.
" *Cerambycina*, nov. nom.
" *Auxesina*, nov.

Subfam. LAMIINAE, sensu novo.

UBER DAS SOGENANNTE TENTORIUM DER PROTUREN

Vorlaufige Mitteilung

von

S. L. TUXEN
Kopenhagen, Danmark

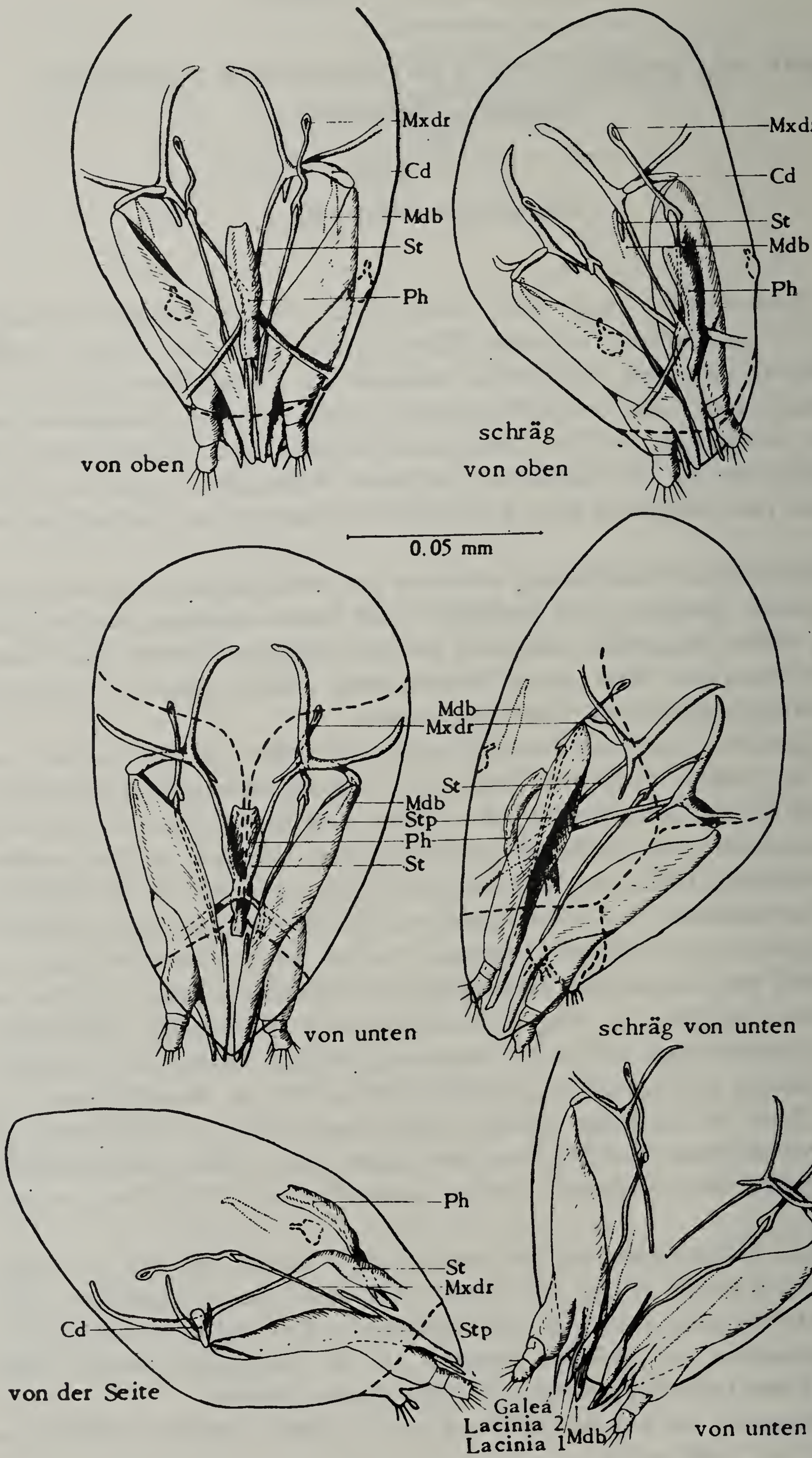
Diese Untersuchung wurde durch einen Brief von R. E. SNODGRASS angeregt. Sie ist an den zwei schwach sklerotisierten dänischen Arten *Acerentulus danicus* Condé und *Eosentomon armatum* Stach ausgeführt und erst vor kurzem, durch eine Gabe von K. STRENZKE, Plön, auch an *Acerentomon doderoi* Silv. ermöglicht, wo die Strukturen deutlicher sind. Da mir aber noch Einzelheiten an den in Milchsäure geklärten Präparaten, sowie an einer Schnittserie unverständlich sind, bitte ich die Mitteilung als vorläufig zu betrachten.

Die beobachteten Verhältnisse sind aus den Abbildungen zu ersehen, die für sich selbst sprechen. Die Mundteile sind bloss skizziert, nur an einer Abbildung näher ausgeführt, und sind mit den üblichen Namen bezeichnet, obwohl ich bisweilen über deren Berechtigung Zweifel hege, – was aber einer späteren Untersuchung vorbehalten bleibt.

Das sogenannte Tentorium besteht aus einem x-förmigen Stützgerüst, das vorne an der Grenze zwischen Frons und Clypeus ansetzt und hinten Gelenkpfannen für die „Cardines" bildet. Dieses Stützgerüst hat, wie ich jetzt glaube, nichts mit dem Tentorium der pterygoten Insekten zu tun, sondern mit H. J. HANSEN (1930) und SNODGRASS (1951) sehe ich es als Sklerotisierungen im sternalen Teile des Kopfes an, den ähnlich benannten Gebilden bei Amphipoden und Isopoden homolog. Es hat auch nichts mit dem von DENIS (1928) bei Collembolen beschriebenen Tentorium zu tun, welches ein mesodermales Gebilde ist, das in Kalilauge und Milchsäure verschwindet (wie auch SNODGRASS, 1951 p. 87, vermutet); DENIS' Deutung des Gebildes bei den Proturen in GRASSÉ's „Traité" (1949 p. 188) ist deshalb falsch, da PRELL's Tiere in Kalilauge geklärt wurden und meine in Milchsäure; die von uns beschriebenen Gebilde sind also gegen diese Mittel widerstandsfähig und ectodermalen Ursprungs. Meine eigene Deutung (1931) ist also auch falsch.

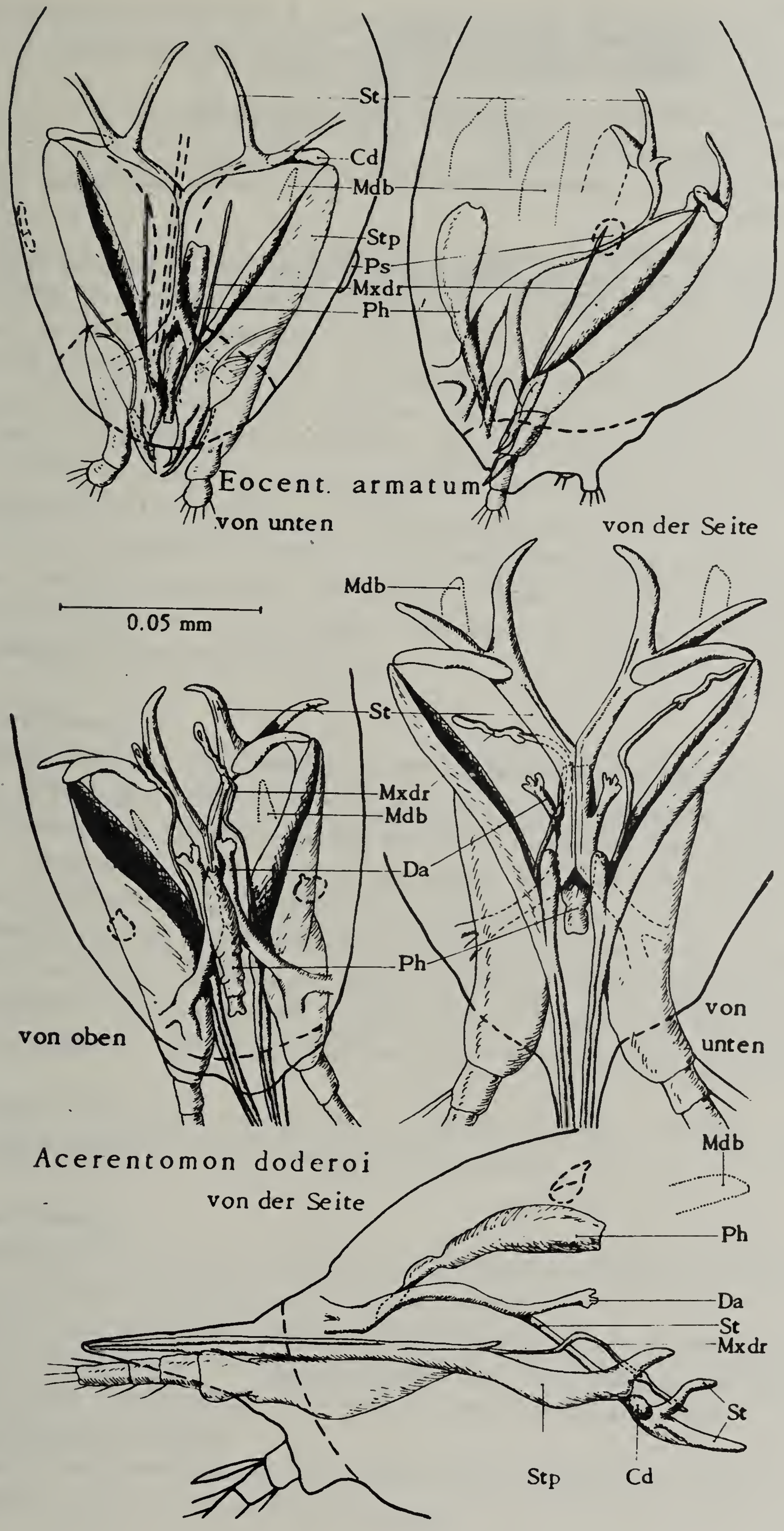
An meinen Abbildungen ist der ectodermale Pharynx deutlich zu sehen; er wurde von PRELL (1913) als dorsale tentoriale Arme aufgefasst. Wirkliche dorsale und also deswegen auch apodemale Arme habe ich nur bei *Acerentomon* gesehen; mit welchen Muskeln sie in Verbindung stehen, weiss ich nicht. Einen Hypopharynx habe ich nicht finden können.

Das Stützgerüst ist bei der Prälarve nur als zwei einfache Stäbchen zu sehen (TUXEN, 1949, p. 33).



Acerentulus danicus

Cd Cardo, *Da* dorsale Apodeme, *Mdb* Mandibel, *Mxdr* sog. Aufhängeband der Maxillardrüsen, *Ph* Pharynx, *Ps* Pseudoculus, *St* Sternalgerüst, *Stp* Stipes.



Cardo, *Da* dorsale Apodeme, *Mdb* Mandibel, *Mxdr* sog. Aufhängeband der Ma-
drüsen, *Ph* Pharynx, *Ps* Pseudoculus, *St* Sternalgerüst, *Stp* Stipes.

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L'HOMOGENEITE DE LA MORPHOLOGIE STERNALE DES BLATTOPTEROIDES (Martynov, 1938)

par
C. DELAMARE DEBOUTTEVILLE
Banyuls-sur-Mer, France

Dans un travail „Sur la Morphologie des adultes aptères et ailés de Zor-
iptères" (1947), j'ai montré que la morphologie thoracique des Zoraptères
:tait voisine de celle des Termites et que l'on pouvait expliquer l'organi-
sation des uns par celle des autres. Ces recherches étaient principalement
basées sur les pleurites et furent étendues par J.P.ADAM et J.LEPOINTE
(1948) à l'ordre des Dictyoptères Mantodea. Notre collègue italien Marcello
LA GRECA (1949) a résumé nos connaissances sur l'évolution des pleures
ptérothoraciques des Blattopteroïdes en plein accord avec nos opinions.

Cette note est consacrée à l'étude de la diversification des sternites pté-
rothoraciques des Blattopteroïdes. Elle essaye d'en décrire les modalités
t de saisir les tendances qui ont guidé l'évolution du sternum à l'intérieur
es quatre grands groupes du Super-ordre.

Sternites des Blattes

La structure ventrale des Blattes a été parfaitement schématisée par
NODGRASS (1935). Le métathorax est composé d'un sternellum rentrant,
n coin, à l'intérieur du basisternite qui est ainsi divisé en deux lobes in-
omplètement séparés à l'avant. Les invaginations furcales sont placées de
art et d'autre du sternellum, à l'arrière de ce sclérite.

Au mésothorax, la desclérification est accompagnée d'une large disjonc-
on des divers sclérites, de telle sorte que le sternellum, qui porte les in-
ginations furcales, est longuement disjoint, vers l'avant, des deux lobes
sisternaux largement séparés. Le spinasternite est, lui-même, complète-
ent isolé.

La réalisation de ce type schématique est plus ou moins poussée selon
s lignées (*Gyna cafrorum* et *Phyllodromia germanica*).

Sternites des Mantes

Chez les Mantes on observe le même type structural que chez les Blattes,
is la suture des divers sclérites est très accentuée.

Au métathorax le sternellum pénètre complètement, sous forme d'une
oite bande (correspondant a l'*intersternellum* de FULLER), à l'intérieur
basisternite. Les invaginations furcales se trouvent ainsi tirées à l'in-
ieur de ce complexe sclérifié.

Au mésothorax, spinasternite et sternellum sont contigues, le sternellum
iétrant largement entre les lobes basisternaux.

III. Sternites des Termites

Chez les Termites la suture des diverses pièces est poussée à l'extrème mais suivant le même plan que dans les deux Ordres précédents. Au métathorax la fusion entre basisternite et sternellum est maintenant achevée, de telle sorte qu'il ne subsiste plus qu'un unique sclérite en V la pointe tournée vers l'arrière, les invaginations furcales étant situées dans la région postérieure.

Au mésothorax le sternellum correspond à une mince bande traversant le basisternite. Furca et spina forment un complexe unique, avec invagination cruciforme.

IV. Sternites des Zoraptères

La fusion des diverses pièces est encore plus poussée chez les Zoraptères que chez les Termites. Le sternellum n'atteint pas la partie antérieure du basisternite au mésothorax. Mais ici, tant au mésothorax qu'au métathorax les ponts précoxaux sont continus ou presque continus, s'étendant du basisternite au latéropleurite par le latérosternite.

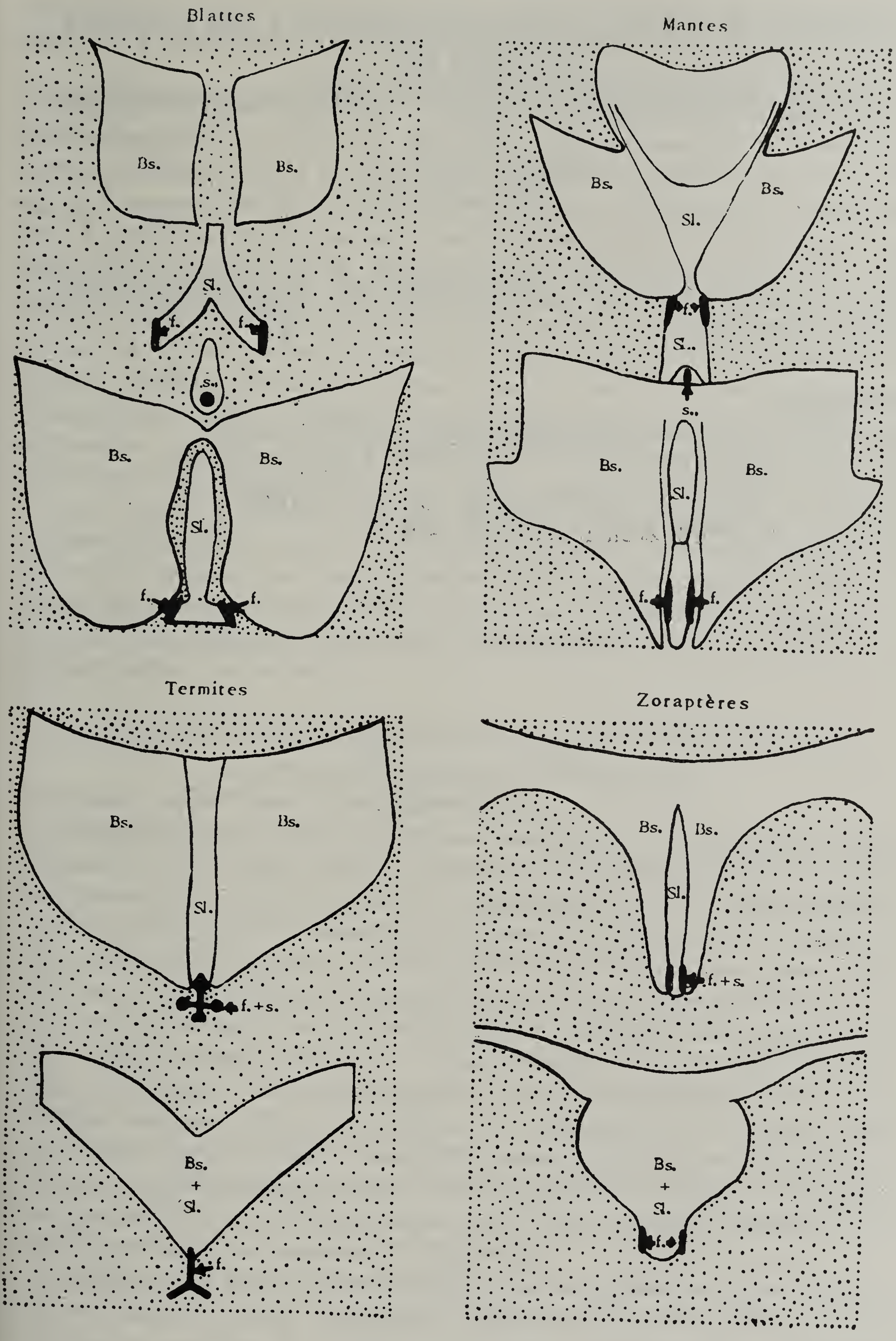
V. Considérations générales

On observe donc, depuis les Blattes jusqu'aux Zoraptères, en passant par les Mantes et les Termites, une tendance marquée à la pénétration du sternellum dans le basisternite, cette pénétration s'effectuant par disjonction médiane de deux lobes basisternaux. Il semble bien que cette tendance évolutive soit de nature à caractériser parfaitement le Superordre des Blattopteroïdes.

Les caractères sternaux viennent donc confirmer l'homogénéité morphologique des Blattopteroïdes en faveur de laquelle les recherches antérieures de DELAMARE DEBOUTTEVILLE (1947) et LA GRECA (1949) fournissaient déjà d'excellents arguments relatifs aux pleures.

Il serait important de savoir quels rapports il est possible d'établir entre les quatre Ordres en cause. La morphologie comparée permet d'affirmer que la succession antéro-postérieure du basisternite, du sternellum et du spinasternite est la disposition généralisée. Il faut, en effet, qu'il en soit ainsi si l'on veut expliquer la morphologie sternale du Super-ordre voisin des Orthoptéroïdes, ainsi que d'un grand nombre d'autres ordres de Pterygotes. Dès lors il faudra admettre que les Blattodea, qui sont aussi actuellement les plus anciennement connus géologiquement, sont les plus primitifs des Blattopteroïdes actuellement vivant. Les Dictyoptères ont certainement un ancêtre commum avec les Protoblattoptères (HANDLIRSCH, 1908) dont sont dérivés indirectement les Termites.

Quant aux Zoraptères il semble logique d'admettre qu'ils doivent être rattachés à la souche des Isoptères car, si leurs sternites sont au même stade



Morphologie sternale des quatre Ordres de Blattopteroïdes. Bs., basisternite. - Sl., sternellum. - f., furca. - s., spina et spinasternite. - f. + s., complexe furco-spinal.

morphologique que ceux des Termites, on a montré (DELAMARE DEBOUTTEVILLE, 1947) que la structure de leurs pleures était plus primitive que celle des Termites et permettait d'en comprendre la genèse.

Il est intéressant de constater combien la nervation alaire est variable à l'intérieur d'un Super-ordre aussi homogène que celui des Blattopteroïdes. Il n'y a rien de commun, au premier abord, entre les ailes primitives des Protoblattoptères Handlirsch et des Isoptères Brullé, si on les compare soit aux ailes compliquées des Dictyoptères Leach, soit aux ailes simplifiées à l'extrême des Zoraptères Silvestri. C'est le mérite de l'éminent paléontologiste MARTYNOV d'avoir saisi les liaisons naturelles qui existent entre ces Ordres d'aspect si divers.

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DONNEES SUR LA MORPHOGENESE DES GENITALIA MALES DES INSECTES
Leur importance pour une nomenclature rationnelle de ces structures

par
CLAUDE DUPUIS,
Paris, France

L'étude morphologique des génitalia mâles des insectes demeure encore le plus souvent descriptive, c'est à dire statique et analytique. Ipso facto, il existe à peu près autant de systèmes de nomenclature que de spécialistes. On doit d'autant plus déplorer cette situation que les données morphogénétiques nécessaires à l'adoption des vues dynamiques et synthétiques sont nombreuses, solides, et tout à fait utilisables comme arguments pour la normalisation de la nomenclature.

Afin d'attirer l'attention sur ces données, j'en ai publié en 1950 dans „l'Année Biologique" (pp. 21- 36) une mise au point accompagnée des références des travaux les plus importants. On trouvera, ci-après, d'abord un résumé de ce travail, puis des exemples des enseignements qu'apporte le point de vue morphogénétique pour la rationalisation de la nomenclature des génitalia mâles des insectes.

I. ORIGINE ET DEVELOPPEMENT DES ORGANES GENITAUX EXTERNES DES MALES D'INSECTES

A. Organes euphalliques et pseudophalliques

R.E.SNODGRASS („Principles of insect morphology", 1935, pp. 587 et suiv.) distingue les génitalia mâles des insectes en *organes phalliques* (en relation directe avec l'introduction de spermatozoides ou de spermatophores dans les voies génitales femelles) et *organes périphalliques* (structures annexes, sans rôle direct dans l'intromission). Cette distinction, outre qu'elle peut être délicate à établir, est basée sur un critère de fonctionnement et ne peut convenir au point de vue morphologique. En effet, elle conduit à confondre sous un même vocable des organes distincts dès l'origine embryologique et à séparer dans des catégories nominales différentes des organes d'origine commune. (Ainsi, le phallus et les paramères des insectes supérieurs sont respectivement considérés comme phallique et périphalliques, bien qu'ils proviennent de la même ébauche d'uropode X, tandis que la plaque sous génitale est dite périphallique, aussi bien que les paramères, alors qu'elle représente les uropodes de l'urite IX).

Le seul critère décisif d'une homologie entre organes est celui d'une origine semblable, à partir d'ébauches comparables par leur génèse et leurs relations de position; le modelé et la fonction ultérieurs de ces ébauches sont sans importance à cet égard. Pour ces raisons, j'ai proposé, pour remplacer celle de SNODGRASS, une distinction nouvelle des génitalia mâles des insectes, basée sur leur origine embryologique.

J'appelle *organes euphalliques* l'ensemble de ceux dérivés d'ébauches préimaginales symétriques logées ventralement entre les urites IX et X, dans une dépression tégumentaire plus ou moins profonde (poche génitale). Ces ébauches (qui ne sont autres que les uropodes X) sont en relation avec l'ultime partie mésodermique du tractus génital mâle (*ampullae*) par l'intermédiaire soit de canaux ectodermiques qui les traversent de bout en bout, soit d'un canal ectodermique médian, creusé entre leurs bases.

J'appelle *organes pseudophalliques* l'ensemble de ceux dérivés des uropodes IX (ou IX et VIII), c'est à dire d'ébauches distinctes dès l'origine des précédentes, qui ne s'enfoncent pas dans une poche génitale et ne possèdent aucune relation avec le ou les canaux éjaculateurs.

Parmi les structures dites couramment „génitalia", il en est (par exemple l'urite IX des Hétéroptères) qui n'ont nullement cette origine appendiculaire et que l'on pourrait nommer „aphalliques"; elles ne seront pas examinées ici, leur signification ne prêtant pas à controverse.

B. Morphogénèse des organes euphalliques

a. Origine embryologique

La question a été définitivement tranchée par l'observation fondamentale de F.L. ELSE (Journ. of Morphol. 55, 1934, pp. 577-609) qui a suivi sans hiatus chez un orthoptère mâle le développement des uropodes embryonnaires du segment X en organes euphalliques. Les ébauches d'uropodes X, en rapport avec les *ampullae* terminales des canaux déférents (diverticules de la cavité coelomique de l'urite X) sont tout d'abord homotopes des uropodes antérieure. Ultérieurement, ces ébauches, synchroniquement aux *ampullae*, migrent en position antérieurs et médiane, jusqu'à se trouver logées au fond d'une poche génitale intersegmentaire, entre les urites IX et X.

Dans tous les groupes d'insectes (Protures et Collemboles exclus) ces ébauches se retrouvent en position comparable. Nombre d'observations concordantes, quoique souvent indirectes, lacunaires ou sommaires, montrent que, dans tous les groupes également, ces ébauches ont la même origine embryologique et représentent les uropodes X. (Chez les femelles, ces ébauches d'uropodes disparaissent très précocement).

b. Différenciation des ébauches euphalliques selon les groupes

Les cas connus sont les suivants:

1. Chaque ébauche euphallique est traversée par un canal ectodermique faisant communiquer les *ampullae* avec l'extérieur:

a. Chaque ébauche reste indivise . . . . Ephéméroptères;

b. Chaque ébauche se scinde en une partie latérale externe (paramère) et et une partie médiane interne (lobe phallique) . . . . . . Dermaptères *).

2. Les ébauches euphalliques ne sont pas traversées par les conduits évacuateurs; il se creuse d'arrière en avant, au fond de la poche génitale entre les bases des ébauches un canal ectodermique impair et médian qui rejoint les *ampullae*:

*) Le schéma se complique ultérieurement par la coalescence plus ou moins totale des lobes phalliques et des canaux éjaculateurs.

a. Les données existantes ne permettent pas de préciser le type de différenciation ultérieur des ébauches phalliques: Incertae sedis (Thysanoures, Diploures, Mallophages);

b. La réduction des organes euphalliques ne permet guère de préjuger de leur type de différenciation: Groupes à organes euphalliques rudimentaires ou vestigiaux (Isoptères, Embioptères, Zoraptères, Plecoptères p.p., Odonates);

c. Les ébauches euphalliques se clivent horizontalement en lobe supérieur et inférieur qui peuvent, selon les cas, rester libres ou devenir plus ou moins coalescents *): Orthoptèroïdes s.l. (Plecoptères p.p., Dyctioptères, Phasmides, Orthoptères *s. str.);*

d. Les ébauches euphalliques se scindent verticalement par l'apex en une partie latérale externe (paramère) et une médiane interne (lobe phallique); les deux lobes phalliques, coalescents ultérieurement, forment dans le prolongement du canal éjaculateur le phallus ou aedeagus: Insectes à paramères (Hemiptères, Trichoptères, Lépidoptères, Hymenoptères, Coléoptères, Diptères, Aphaniptères. . .)

C. Morphogénèse des organes pseudophalliques

L'accord assez général à leur sujet dispense de longs développements. Il s'agit d'organes dérivés des ébauches embryonnaires d'uropodes IX (ou quelquefois VIII et IX s'il y a deux paires d'organes pseudophalliques). Ce sont, par exemple, les organes connus comme „styles" chez les Ephémères, „gonapophyses" chez les Odonates, la plaque sous génitale des Orthoptères, des Homoptères, etc. . . Très souvent, et notamment chez les insectes supérieurs, les ébauches pseudophalliques s'intègrent à la plaque sternale de leur urite, ou disparaissent purement et simplement.

Quoiqu'il en soit, il n'y a pas de cas où les ébauches d'uropodes IX prennent part à la constitution d'organes euphalliques: les devenirs des uropodes embryonnaires IX et X sont absolument distincts, d'où leur discrimination fondamentale en ébauches respectivement pseudo- et euphalliques.

D. Conclusions sur le plan morphologique

Les résultats ci-dessus exposés des études de morphogénèse permettent de décider de l'hypothèse valable entre celles avancées quant aux homologies des organes génitaux externes des mâles d'insectes.

L'origine appendiculaire de ceux-ci ne faisant aucun doute, toutes les thèses d'une origine sui generis sont à abandonner.

Parmi les hypothèses d'une origine appendiculaire, toutes celles qui englobent les génitalia comme dérivant d'une même paire d'appendice le seront également.

Parmi les hypothèses d'une origine à partir de deux paires d'uropodes, celles qui considèrent ces uropodes d'après leur situation définitive chez l'imago sont à rejeter car elles conduisent à admettre deux paires d'uro-

*) Voir M.A.H.QADRI, Trans.R.Ent.Soc.London, 90: 121-275, 1940.

podes sur le segment IX et aucune sur le X, ou, ce qui est pire, la coalescence, jamais observée ontogénétiquement, des urites IX et X.

Les thèses qui admettent une migration d'ébauches restent seules en présence. D'après J.C.KERSHAW et F.MUIR les uropodes VIII auraient migré en position postérieure. On sait maintenant qu'il n'en est rien et que la seule thèse conforme aux faits est celle de l'origine des organes euphalliques à partir des ébauches d'uropodes X ayant migré anterieurément.

Pour plus ample discussion, références et exemples, je renvoie le lecteur à mon travail déjà cité.

II. PROGRES POSSIBLES EN MATIERE DE NOMENCLATURE PAR LA PRISE EN CONSIDERATION DES DONNEES MORPHOGENETIQUES

La connaissance des faits de morphogénèse peut aider à amender la nomenclature des génitalia mâles des insectes, ainsi que le montrent les quelques exemples suivants choisis parmi les plus typiques:

1. Les organes euphalliques ne doivent pas porter de noms empruntés à la nomenclature des génitalia ♀, puisqu'ils ne présentent pas d'homologues chez les femelles où les gonopodes X disparaissent. En particulier, les paramères ne doivent jamais être appelés gonapophyses.
2. Les organes qui ne représentent qu'une partie d'appendice (paramères = parties d'uropodes X) ne doivent pas être nommés comme des appendices entiers, au demeurant mal numérotés („gonopodes IX").
3. La multiplicité des termes (harpagones, claspers, forcipules, valvae, harpes . . .) pour les paramères peut disparaître, les paramères étant homologues chez tout les insectes supérieurs.
4. Les formations secondaires du phallus (endophallus impair et processus pairs variés) ne doivent pas recevoir les noms réservés aux structures fondamentales (aedeagus, paramères).
5. Il est inutile de rechercher à toute force des homologues d'une plaque sous génitale pour les trouver, et les nommer, là où ils ont disparu!

DISCUSSION

Mr. **van Emden**: A quel segement Monsieur DUPUIS assigne-t-il la papille anale des larves d'holométaboles, structure connue comme segment X?

Mr. **Dupuis**: A mon avis, et presque sans aucun doute, la „papille anale" chez les Holométaboles comme chez les Hémiptères, les Orthopteroides s.l., etc. . représente le segment abdominal XI. Je suis persuadé que seule la méconnaissance des données acquises en embryologie, plusque leur insuffisance permet encore de croire qu'il s'agisse de l'urite X. Quoiqu'il en soit, l'embryologie des organes génitaux mâles des insectes ne saurait trop être étudiée spécialement chez les larves de Diptères, Hymenoptères et Lépidoptères.

ON A CASE OF GYNANDROMORPHISM IN THE HONEY BEE (Apis mellifica L.)

by

A.M. da COSTA LIMA

Sao Paulo, Brasil

VON SIEBOLD (1864), in his classic paper "Über Zwitterbienen", reporting the occurence of numerous gynandromorphs in a hive of bees of Eugster, apiarist of Constance, referred to the cases of gynandromorphism in bees previously observed by other bee breeders. According to him, it seems quite sure that the first observation of the phenomenon was made by LUCAS, a school and bee master when he reported the occurrence of sting drones, "Stacheldrohnen", as he named them.

The discovery of LUCAS, communicated in a paper of LAUBENDER (1801), was considered by his contemporaries a falsehood and even was severely criticized by the pastor WURSTER.

As the consequence of such injustice it was entirely neglected till 1860 when came to light the observations of DÖNHOFF and of WITTHENHAGEN on bees showing characters of both sexes. These observations were supported by the publication of the famous Professor of Zürich of the first account on the existence of gynandromorphs in Eugster's bee hive.

Since then, as we can see in the paper of DALLA TORRE and FRIESE, the occurrence of gynandromorphism in bees has been observed almost exclusively in solitarian species belonging to genera different from *Apis*.

Probably cases of gynandromorphism in *Apis mellifica* must be relatively rare as we can infer from the quotation found in the following sentence of ANDREWS: "Gynandromorphs seem to be rare amongst bees. PERKINS (1922, J. Torquay Nat.Hist.Soc. 3: 131-136) found only two amongst 20.000 specimens of bees and wasps".

Also by a careful search of the literature on the subject, I was not able to find, besides the papers here mentioned, any other reference of a so perfect case of gynandromorphism in common bees, as the one I am presenting you in this note.

On September 1950, Mr. Pierre GUÉRIN, a French apiarist, then working in the Sector of Apiculture of the CNEPA (National Center of Studies and Agronomic Researches), situated in the neighbourhood of our University (Universidade Rural), discovered and gave me a bee quite different from those he was accustomed to see. From the letter he wrote to me about the insect, I cite, as the most interesting, the following lines:

„Race d'origine consideré — type italienne, sans certitude exacte, mais actuelement dans un état complet de dégenérescence, car il y a des abeilles et des mâles de toutes couleurs, dans toutes les ruches du Secteur d'Apiculture. *Sexe* — Mâle-

petit, ½ grosseur naturelle environ, parce que né dans une cellule d'ouvrière."

Upon receiving the example I verified it was a perfect gynandromorph, belonging to the group of *lateral gynandromorphs* of DALLA TORRE & FRIESE (*Sagittal Gynandromorphen* of ENGELHARDT), precisely of the type described and illustrated by BOVERI in plate 7, fig. 1, of his paper.

In our gynandromorph it occurs a perfect differentiation of the two sides of the body: the left side representing the left half of a drone; the right side the right half of a worker. This can be observed not only as far as the external anatomy in concerned, but also in relation to the internal sclerotical genital structures.

The abnormal aspect of the head, with an asymmetrical displacement of the ocelli and enormous development of the left eye, shows clearly at the middle of face the colour separation of the two halves of that part of the body. The antenna of the left side in typically a male antenna. The antenna of the right side shows the characters of a worker antenna. As for the legs of the same half, they are distinctly lighter than the same parts of the left or male side.

Differences in the development of the mandibles and maxillae can be detected in the microscopical preparation, also corresponding to the distinctions observed in the mouth pieces of drones and workers. Even the labium is somewhat asymmetrical, on account of the developmental differences in the two sides.

More easily seen are the differences found in the legs, particularly in the posterior ones.

As for the abdomen, after its diaphanization, the microscopical inspection reveals one half of the male genitalia in the left side *), and the right half of the sting pieces in the right side.

As Mr. GUÉRIN was not able to give me any further information about the origin of this gynandromorph, especially on the race of the queen which produced it, I cannot give in this paper explanatory remarks on what seems to me the most interesting investigation to be made in a case of gynandromorphism like this, viz., to say, after a detailed study of the racial morphological characters of the male side of the body, whether they are exclusively matroclinous, or of biparental origin.

Fig. 1. *Apis mellifica*, lateral gynandromorph. Fig. 2. Front view of the head. Fig. 3. The head, after diaphanization, front view; *L*, left side; *R*, right side. Fig. 4. The antennae; *L*, left side; *R*, right side. Fig. 5. The mouth parts; *gl*, glossa; *L*, labium; *Llp*, left labial palp; *LM*, left maxilla; *Lmp*, left maxillar palp; *m*, mentum; *Rlp*, right labial palp; *RM*, right maxilla; *Rmp*, right maxillar palp; *sm*, submentum. Fig. 6. Posterior leg of left side (♂). Fig. 7. Posterior leg of right side (♀).

*) On this same side there are, externally, the two claspers, great and small, distinctly visible; they are absent on the right or worker side.


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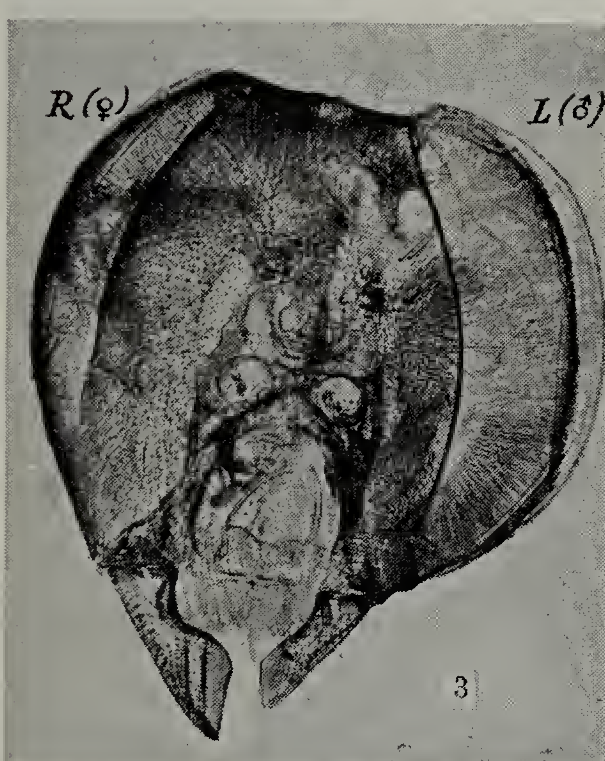
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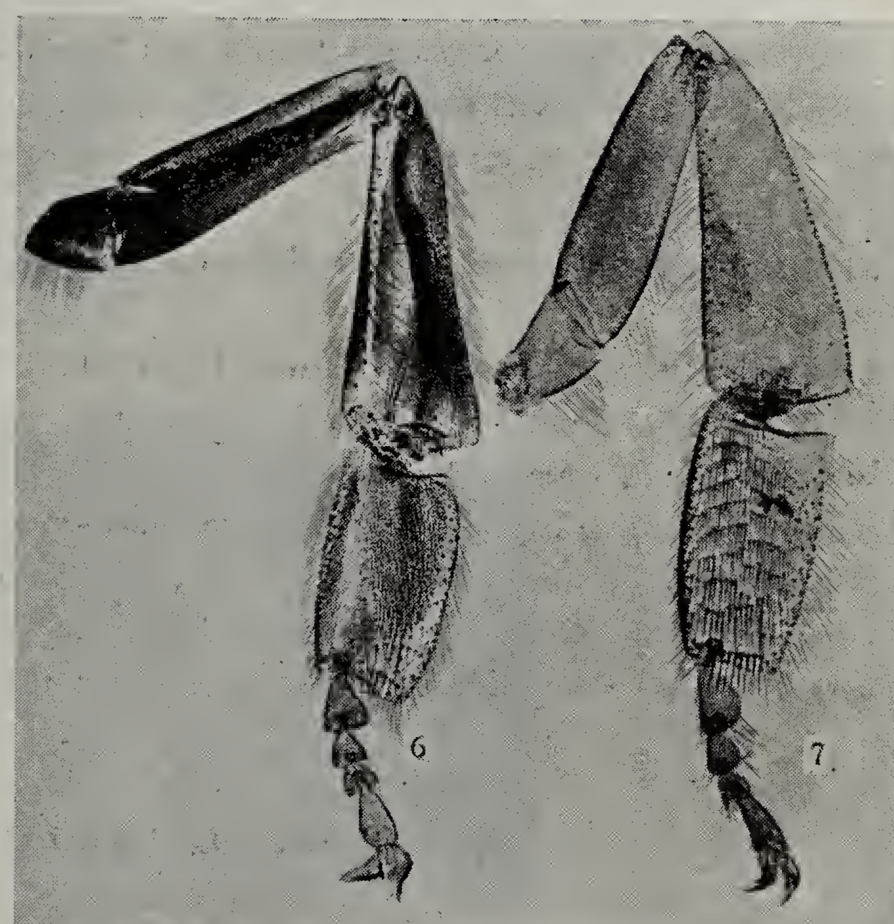
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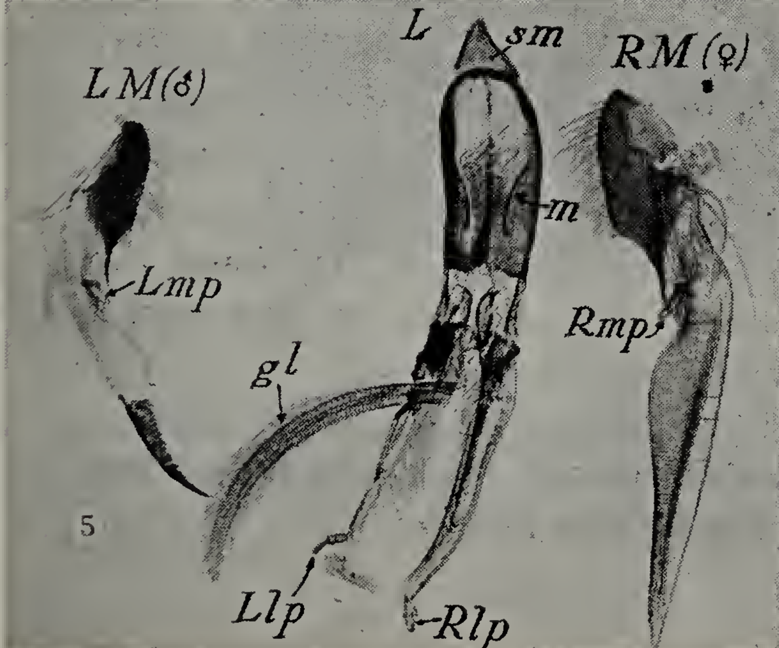
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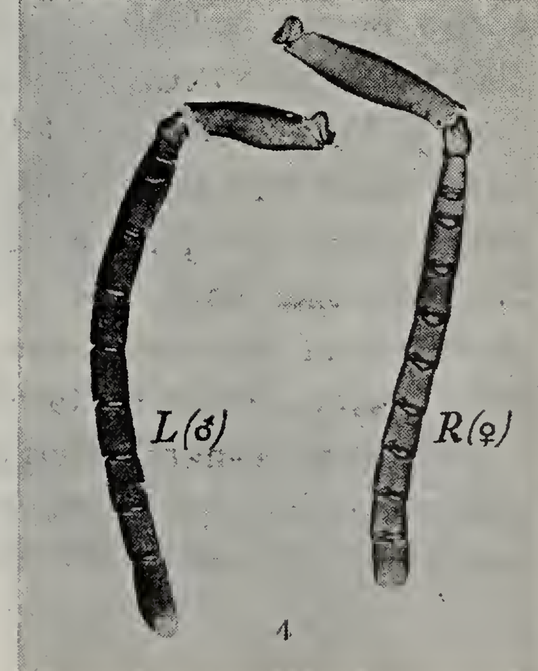
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The investigation would be very interesting indeed, as it would show which is the sure interpretation for explaining gynandromorphism or sex determination in the bee, whether it is the retarded or partial fertilization of BOVERI, the polyspermy of MORGAN, or the opinion of MORGAN & BRIDGES that in bees, as in *Drosophila* gynandromorphs, occurs an accidental elimination of a sex chromosome during cleavage.

So, it seems to me that, under that view point, we are still with the same knowledge of the subject as was exposed by CREW in his paper on the subject, mentioned in the literature.

Concluding this note I must remark that, notwithstanding my efforts for getting more material, I did not succeed to receive any more gynandromorphs from the same hive.

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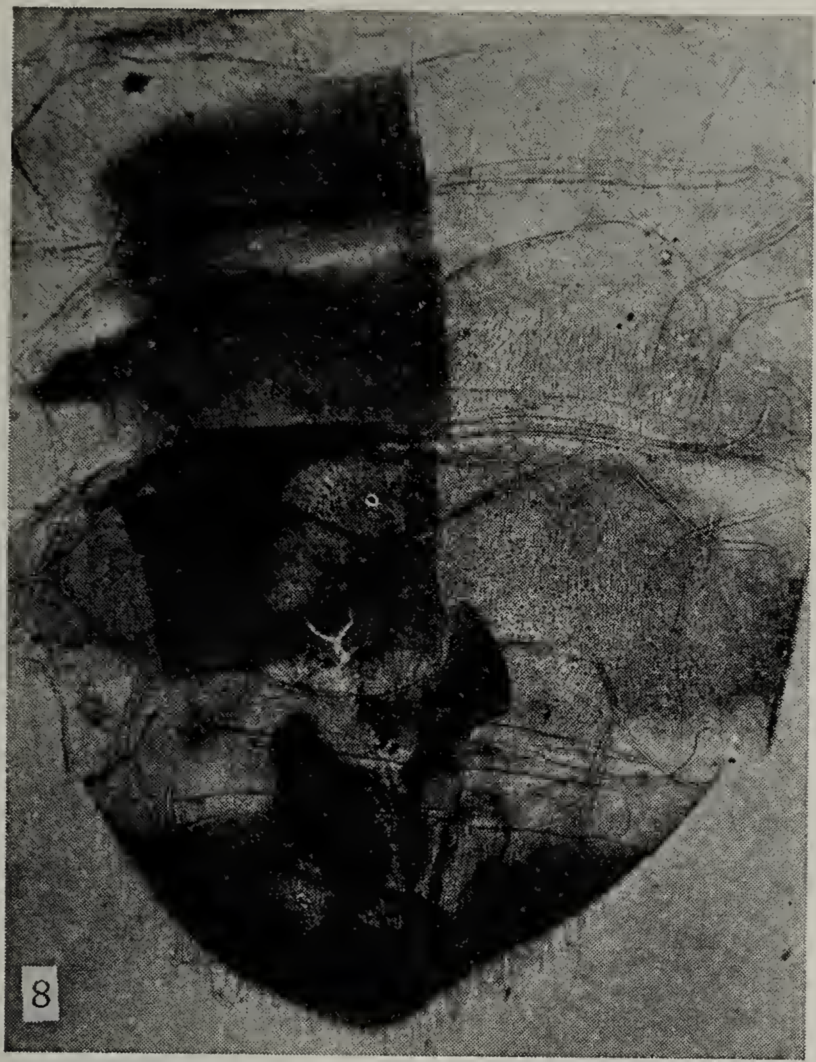
DISCUSSION

Mr. **Manning:** A suggested explanation of the described gynandromorph was given, as follows – in the honey bee (*Apis mellifera* L.) sex is determined by the balance of autosomes to sex chromosome, i.e. 15/IX ♂ and 30/IX ♀ (MANNING, F.J., 1949, "Microscope", London; KERR, W.E. 1951 (Jan.), "Evolution"). It follows, therefore, that a doubling of the autosome complement of one of the two cells of the male egg at the 2-celled cleavage stage would give, for all cells subsequently derived from it, female tissue. On the other hand, the second cell of the cleavage nuclei, in which the doubling of the autosomes has not occurred, will continue to give entire male tissue. Hence a "lateral" gynandromorph will be produced.

Moreover, gynandromorphs are not really uncommon in honey bee communities but their presence quite often passes undetected since they are frequently destroyed by the other normal workers of the hive.



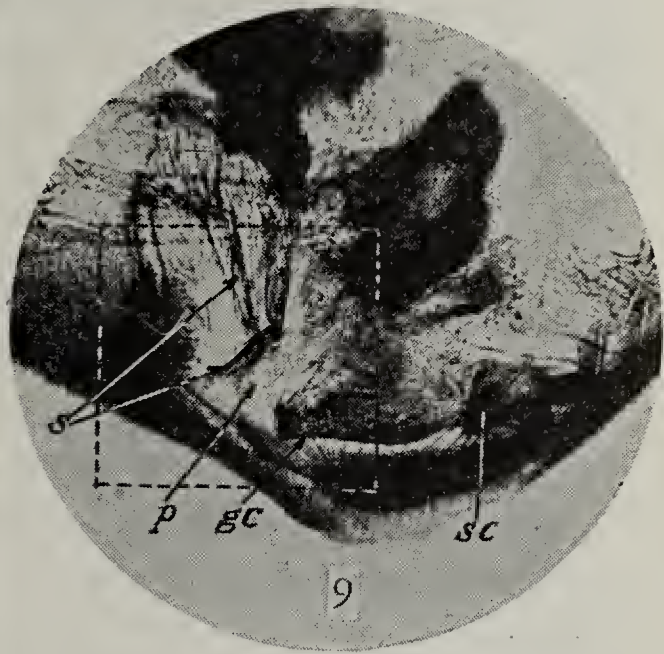


Fig. 8. Posterior part of abdomen, after diaphanization (dorsal view). Fig. 9. Tip of abdomen, after diaphanization, ventral view. The marked quadrangular area is considerably enlarged in fig. 10; *gc*, great clasper; *p*, aedeagus; *s*, sting pieces; *sc*, small clasper. Fig. 10. Quadrangular area of fig. 9 considerably enlarged (letters as in fig. 9).

Mr. **da Costa Lima:** Many thanks to Mr. MANNING for the genetical explanation of my note.

I did not consider genetical interpretation of the observed case. My intention was mainly to emphasize, out of a morphological point of view, the differences between the two sides of the examined bee, especially those found in the mouth parts and those of the genital sclerotized parts of male and worker, which were not yet described by previous authors.

STRUCTURE DU THORAX DES MEGANEURIDES (PROTODONATES)

par

F. CARPENTIER et M. LEJEUNE-CARPENTIER

Liège, Belgique

Dans une première note (1950) sur la morphologie des Méganeurides de Commentry, nous n'avons pu faire que des remarques assez vagues concernant le thorax de ces remarquables Insectes. Six spécimens de la collection du Muséum de Paris comportant, plus ou moins bien conservées, des parties au moins de la région thoracique se trouvaient cependant à notre disposition. Sans perdre de vue les pièces, nous en avions executé des tracés à la plume sur photo agrandie. Mais ces dessins, d'exactitude d'abord très relative, durent être recommencés à plusieurs reprises *). Nous les croyons devenus finalement assez concordants pour autoriser la présentation de cette note. Un exposé plus étendu sur le thorax des Méganeurides est en préparation; on y trouvera les images qui manquent ici **).

Pronotum

Le premier anneau thoracique des Méganeurides n'était évidemment ni réduit au point de pouvoir rentrer dans la concavité postérieure de la tête, comme sur la reconstitution de CH.BRONGNIART (1894, pl. 28), ni „égal à chacun de deux autres segments", comme l'a écrit A.LAMEERE (1934, p. 215). D'autre part, nous l'avons trouvé d'une forme plus semblable à celle des segments ailés que les auteurs ne l'ont pensé.

Sur *Meganeurula selysii* Brongn. type, le pronotum comporte, en plus d'une partie médiane correspondant au pronotum des Libellules actuelles, de grands paranota dont ces derniers Insectes ne conservent que des vestiges. Il s'agit de lames disposées horizontalement; leur zone centrale circulaire plus épaisse est armée de grosses épines et des rayons semblent en partir soutenant la région distale foliacée que nous ne sommes pas parvenus jusqu'ici à délimiter. Les paranota embrassent et recouvrent en partie sur les côtés l'arrière de la tête.

Le pronotum plus délabré du type de *Meganeura rapax* Handl. a été pris par A.HANDLIRSCH pour une tête ***). Les yeux qu'il a cru y voir et qu'il a dessinés (1919, fig. 67, p. 569) représentent en réalité la zone centrale des paranota.

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*) Nous remercions encore Mr. le Prof. C.ARAMBOURG, Directeur, et Mr J.ROGER, Sous-Directeur, du Laboratoire de Paléontologie du Muséum pour la bonté et... la patience qu'ils nous ont témoignées.

**) Quelques photos furent exhibées lors de la présentation de cette note au Congrès.

***) On sait que A.HANDLIRSCH n'a pas étudié le fossile même, mais la phototypie que F.MEUNIER (1909, pl. III, fig. 2) en a publiée.

Mésopleures

Les épisternes mésothoraciques de droite et de gauche, au lieu de monter en avant de l'attache des ailes antérieures, comme ils le font chez les Libellules, au point de ne plus être séparés l'un de l'autre supérieurement que par une „carène médio-dorsale", restent, chez les Méganeurides, plus ou moins distants. A.HANDLIRSCH (1920, fig.72) les avait figurés ainsi, mais d'autant plus schématiquement qu'il n'a réalisé à ce sujet aucune observation valable. Effectivement la seule pièce De Commentry montrant bien les mésépisternes est le type de *M. rapax*; le mésothorax de ce spécimen, en dépit de la mauvaise impression qu'il a laissé à F.M.CARPENTER (1943, p.542), est remarquablement bien conservé. Mais, puisque A.HANDLIRSCH a confondu le pronotum du spécimen avec la tête, il ne peut être parvenu à en situer correctement les mésépisternes.

Personnellement, nous voyons les mésépisternes droit et gauche avancer un coin chacun dans le territoire dorsal, mais en s'arrêtant à quelque distance l'un de l'autre. Dans l'intervalle, persiste une région préscutale qui, vers l'avant, s'élargit en triangle; le dispositif rappelle ce que l'on peut observer chez une nymphe de Libellule Anisoptère.

Les épisternes mésothoraciques de *M. rapax* portent des traces évidentes d'une sculpture qui devait être fortement marquée; ce sont des crêtes plus ou moins sinueuses soulevées en certains points pour former de grosses épines *).

Bordant extérieurement le mésépisterne gauche sur le type de *M. rapax*, l'apodème pleural, très oblique, fait un coude prononcé près de l'aile, formant un fulcre dont l'extrémité s'est imprimée en la pièce humérale. Le fulcre seul se voit très bien, à gauche aussi, au voisinage immédiat de l'humérale, sur le type de *Meganeura monyi* Brongn.

Mésonotum

Le seul auteur qui ait essayé d'en restaurer la structure est R.J.TILLYARD (1917, fig.156, p.303) mais son dessin est très grossier. Le scutum du mésothorax constitue chez les Méganeurides étudiés une plaque au moins aussi large que longue. Le scutellum est en X comme celui des Libellules, avec une région médiane culminante et des ailes latérales. Le postscutellum est court.

La pièce articulaire humérale est particulièrement distincte chez *M. monyi*. On la retrouve dans les autres espèces si l'on tient compte des rapports typiques de la pièce avec les nervures longitudinales les plus antérieures de l'aile. Elle est bien plus proche du scutum que ne l'a représentée R.J.TILLYARD (loc. cit.) **). La pièce articulaire auxillaire, épaisse et fortement sculptée, est particulièrement visible sur les spécimens de *Meganeura* s. str.

*) De façon générale, la paroi du corps des Protodonates devait préêtre d'une rigidité qu'on ne retrouve pas chez les Odonates actuels.

**) Cet auteur, en attachant les ailes au corps de sa *M. monyi*, semble avoir pensé plus à une Embie qu'à un Odonatoptère.

Métanotum

Son préscutum, court, tout à fait transversal, est assez distinct chez *M. selysii*. Le scutum, chez cette même espèce, est plus étendu en longueur et en largeur que celui du mésothorax. Le scutellum et le postscutellum ne sont pas plus allongés que ceux du deuxième segment.

La pièce articulaire humérale ressemble beaucoup à celle du mésothorax. L'axillaire est plus grande et fortement sculptée, montrant chez *M. selysii* des crêtes sinueuses rayonnantes.

Dessous du thorax

Il semble qu'aucun auteur jusqu'ici ne se soit aperçu que le type de *Meganeurula confusa* Handl. se présente du côté ventral. Ce spécimen d'ailleurs, en bien des points du corps, n'est constitué que par une empreinte, un négatif fort difficile à déchiffrer. A.HANDLIRSCH, sur son croquis (1919, fig. 68, p. 570) a donc laissé le corps entièrement en blanc.

Heureusement, parmi les très nombreux rebuts de la collection De Commentry, nous avons découvert la contre-empreinte du corps de *M. confusa*, le positif. Cette pièce porte au verso une étiquette de F.MEUNIER; on y lit qu'il s'agit probablement d'un Méganeuride, mais en tel état qu'aucune détermination un peu précise n'est possible. Il s'agit bien cependant de la contre-empreinte de *M. confusa* et, comme certaines parties du squelette ventral arrachées au type lors du dégagement de celui-ci s'y retrouvent, nous avons été heureux de pouvoir l'étudier.

Il a été ainsi reconnu que les hanches prothoraciques de *M. confusa* se présentent à la fois comme très antérieures et rapprochées entre elles. Abstraction faite même de l'existence des paranota du prothorax, elles n'étaient donc pas visibles de dessus, ainsi que les a représentées A.HANDLIRSCH (1920, fig. 72). Les hanches intermédiaires sont insérées peu en arrière des antérieures et ne sont guère plus distantes l'une de l'autre que ces dernières. Les hanches postérieures sont, par contre, notablement écartées et éloignées des intermédiaires. Par ces derniers caractères et d'autres antérieurement signalés, *M. confusa* ressemble plus aux larves des Odonates Anisoptères actuels qu'à leurs adultes.

L'étude, laborieuse – on le conçoit – des sclérites ventraux n'est pas terminée. Cependant, à considérer simplement l'ampleur de ce que nous appellerons ici – grosso modo – le métasternum, on peut supposer que les rentrées endosternales ne devaient pas être aussi considérables chez le Méganeuride que chez l'adulte des Anisoptères.

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UNTERSUCHUNGEN UBER DIE ZEITLICHE VARIABILITÄT DES SEGELFALTERS
(Iphiclides podalirius L., Lep.)

von
Theodor A. WOHLFAHRT
Würzburg, Deutschland

Die vorliegenden Untersuchungen betreffen die normale Variabilität der gen.vern. und der gen.aest. des Segelfalters (*Iphiclides podalirius* L.) im Vergleich miteinander. Sie wurden durch die auffallende Verschiedenheit im Aussehen der beiden Generationen einer unterfränkischen Population aus dem Maintal nordwestlich von Würzburg in dem heissen Jahr 1947 angeregt. Unterschiede zwischen Rassen und Generationen werden bei Lepidopteren im allgemeinen durch Worte beschrieben, die selbst bei guter Kenntnis der betreffenden Art häufig recht verschiedene Deutung zulassen. Dem gegenüber wurde nach Freilandserien von dem genannten Fundort aus den Jahren 1947 bis 1951 versucht, für den Segelfalter wesentliche Merkmale und Generationsunterschiede objektiv in Zahlenwerten zu ermitteln.

Zu diesem Zweck vorgenommene Messungen erstrecken sich neben Schuppen, männliches Genitalapparat und Zeichnung besonders auf die Flügelform. Sie fand bisher verhältnismässig wenig Beachtung, wenn man von den Messungen der Vorderrandslänge der Vorderflügel zu Grössenvergleichen absieht (BEALL u. WILLIAMS 1945). Durch Verbindung bestimmter Messpunkte an den Flügeln ergaben sich Masseinheiten, welche die Berechnung vergleichbarer Relativwerte erlaubten. So wurde die Verbindung der beiden äussersten Vorderflügelspitzen als „Spannweite" bezeichnet, die grösste Länge der beiden Vorderflügel ergab zusammen mit der Thoraxbreite die „Flugspanne" (= weiteste Ausbreitung der Flügel während des Fluges) (Abb. 1).

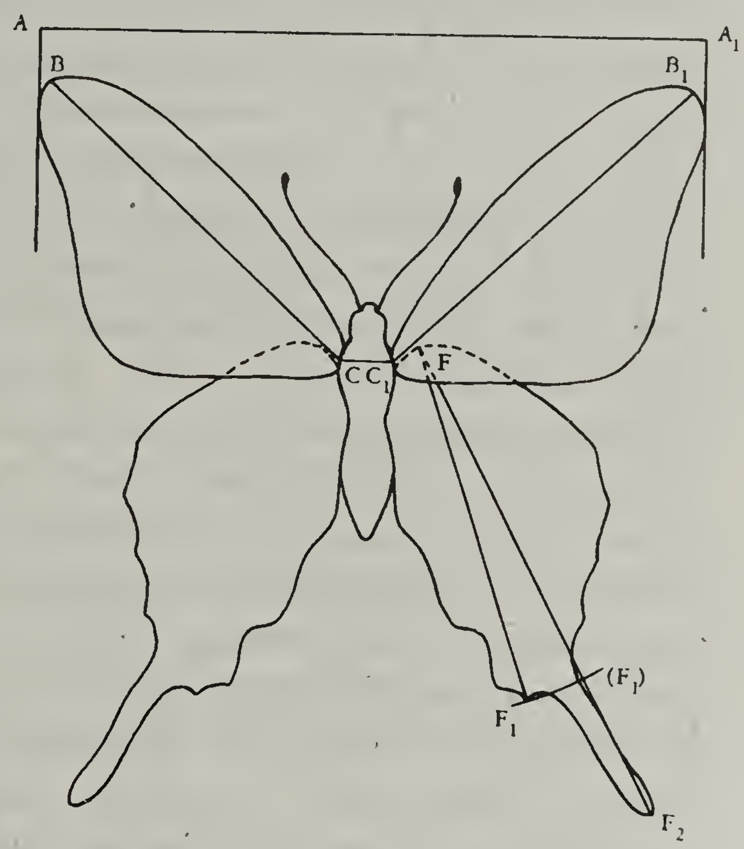

Abb. 1. Messpunkte und Masseinheiten an den Flügeln von *Iphiclides podalirius*. AA_1 Spannweite, BCC_1B Flugspanne, FF_1 Hinterflügellänge, $(F_1)F_2$ absolute Schwanzlänge.

Bedingung für die Verwendbarkeit dieser Masse war die einheitliche Präparation der Falter derart, dass distales und proximales Ende jeder 2. Analader beider Vorderflügel auf einer Geraden lagen. Um unmittelbar vergleichbare Werte zu erhalten, wurde jeweils ein kleinerer empirischer Wert in % des entsprechenden grösseren ausgedrückt. So ergab die Spann-

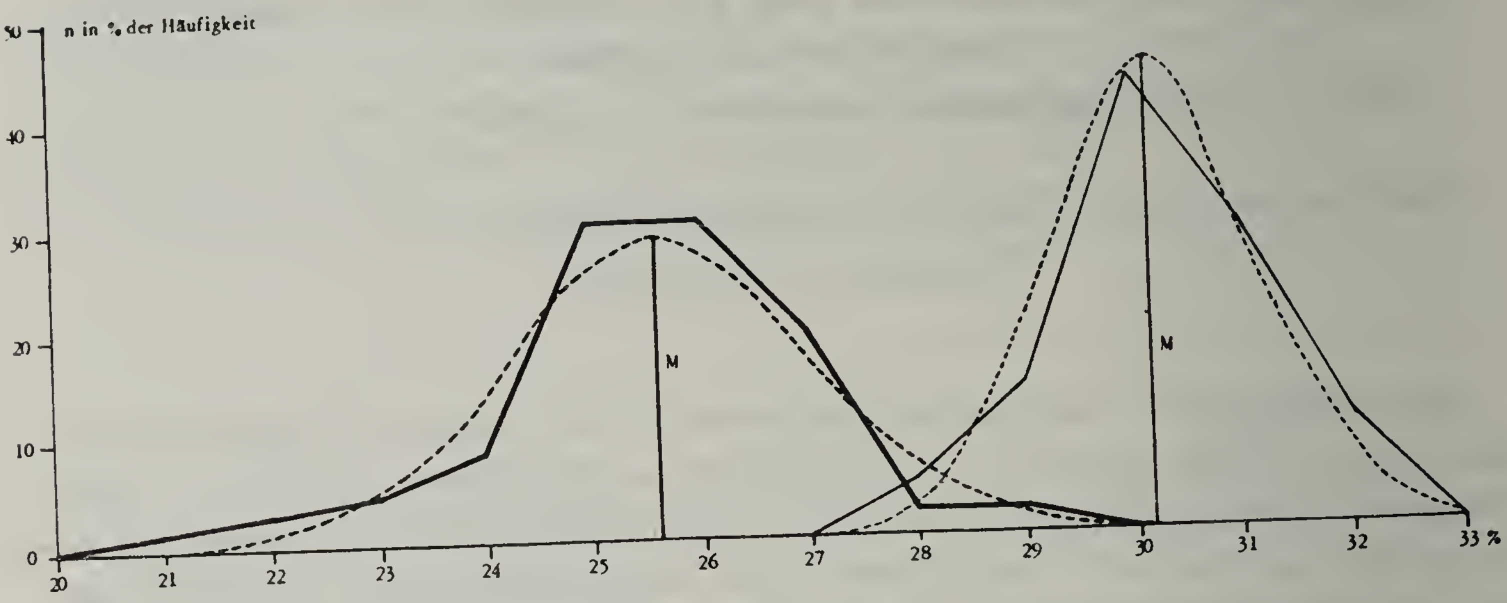

Abb. 2. *I.podalirius*. Variationsbreite der relativen Schwanzlänge einer unterfränkischen Population. Wagrecht Schwanlänge in % der Hinterflügelsamtlänge. Senkrecht Individuenzahl in % der Häufigkeit der Klassenwerte. —— gen.vern. 1947-51 (n = 96 ♂♂), —— gen.aest. 1947,49,50 (n = 21 ♂♂), M Mittelwert. Genauere Daten auf Tabelle 2.

weite in % der Flugspanne die „relative Spannweite". Auf andere Masse der Vorderflügel kann aus technischen Gründen nicht eingegangen werden, sie müssen einer ausführlicheren Darstellung vorbehalten bleiben. Am Hinterflügel bildet die geradlinige Verbindung des am weitesten cranial gelegenen Punktes mit dem Ende des Schwanzfortsatzes der 3. Medianader die „Hinterflügelgesamtlänge" und die Verbindung eben dieses Punktes mit dem distalen Ende der 1. Cubitalader die „Hinterflügellänge". Durch Subtraktion der Hinterflügellänge von der Hinterflügelgesamtlänge wurde die „absolute Schwanzlänge" errechnet, die entsprechend in % der Hinterflügelgesamtlänge ausgedrückt die „relative Schwanzlänge" ergab. Der besondere Vorteil der Einführung von Relativmassen liegt neben der unmittelbaren Vergleichbarkeit darin, dass auch sehr verschieden grosse Falter in ihren Proportionen so ähnlich sind, dass noch verhältnismässig kleine Serien statistisch brauchbares Material liefern. So konnte z.B. in einem Falle bei der geringen Zahl von nur 21 Tieren eine nahezu ideale binomiale Verteilung der Relativwerte beobachtet werden (Abb. 2). Alle derart exakt feststellbaren Merkmale wurden nach Möglichkeit variationsstatistisch erfasst. Der Einwand, dass sich die Flügelform infolge der mechanischen Beanspruchung durch den Flug wesentlich verändere, konnte vernachlässigt werden, da den Messungen Freilandmaterial zugrunde lag, das bereits einige Zeit geflogen war. Während die grundlegenden Messungen an Faltern der genannten unterfränkischen Population ausgeführt wurden, standen zum Vergleich einige Freilandserien von weit entfernten Fundorten zur Verfügung (Oberbayern, Nordtirol, Kleinasien u.a.).

Vor der Betrachtung der Ergebnisse hinsichtlich der relativen Spannweite ist festzustellen, dass ihre Werte ein Urteil über die Gestalt der Vorderflügel erlauben. Je göszer der Wert, desto breiter, je kleiner, desto schmäler und höher sind die Vorderflügel des betreffenden Falters. Tabelle 1 zeigt, dass dieses Merkmal nach der Generation verschieden ist und auch geographische

Tabelle I

Population	Jahr	gen. vern.							gen. aest.						
		n ♂	M	m	–	+	σ	v	n ♂	M	m	–	+	σ	v
Unterfranken, Maintal nordwestlich von Würzburg	1947	6	**79**		77,8	80,7			5	**77**		73,4	81,4		
	1948	10	**78**		76,6	81,9			6	**76**		73,0	78,6		
	1949	22	**78**		73,2	81,3			4	**76**		75,0	76,8		
	1950	23	**78**		75,0	81,9			12	**76**		72,6	79,8		
	1951	36	**79**		75,6	85,3									
	vern. 1947-51 aest. 1947-50	97	**79**	0,2	73,2	85,3	1,94	2,4	27	**76**	0,4	72,6	81,4	2,2	2,8
Oberbayern Leizachtal	1942,45,47 48,49,50	19	**79**	0,6	73,9	83,4	2,61	3,3	einbrütig						
Nordtirol Brandenberg	1939,41, 44,50	12	**81**	7,7	76,7	85,1	2,23	2,7	einbrütig						
Nordsyrien Marasch im Zentral-Taurus	vern. 1930 aest. 1929	6	**75**		71,9	77,4			26	**74**	0,4	69,5	78,4	2,08	2,8

Tabelle II

Population	Jahr	gen. vern.							gen. aest.						
		n ♂	M	m	–	+	σ	v	n ♂	M	m	–	+	σ	v
Unterfranken, Maintal nordwestlich von Würzburg	1947	6	**25**		24,0	27,0			5	**31**		31,0	32,0		
	1948	10	**25**		22,0	27,0			6	**28**		23,0	30,0		
	1949	22	**26**		23,3	28,5			4	**31**		29,2	31,7		
	1950	23.	**26**		23,1	27,8			12	**30**		28,2	31,2		
	1951	35	**25**		21,4	28,9									
	vern. 1947-51 aest. 1947,49,50	96	**25**	0,14	21,4	28,9	1,42	5,5	21	**30**	0,2	28,2	32,0	0,9	2,97
Oberbayern Leizachtal	1942,45,47 48,49,50	19	**26**	0,5	22,4	29,8	2,16	8,3	einbrütig						
Nordtirol Brandenberg	1939,41 44,50	11	**23**		20,3	25,9			einbrütig						
Nordsyrien Marasch im Zentral-Taurus	vern. 1930 aest. 1929	6	**27**		25,3	28,3			24	**32**	0,3	29,7	35,9	1,62	5,0

Tab. 1. *I.podalirius.* Mittelwerte der relativen Spannweite verschiedener Populationen. n Anzahl der bearbeiteten Individuen, M Mittelwert, m mittlere Streuung des Mittelwertes, – Minimalwert, + Maximalwert, σ Streuung, v Variationskoeffizient.

Tab. 2. *I.podalirius.* Mittelwerte der relativen Schwanzlänge verschiedener Populationen. Bezeichnungen wie auf. Tab. 1.

Verschiedenheiten aufweisen kann. Der Mittelwert für die gen. aest. der unterfränkischen Population liegt um 3% niedriger als derjenige für die gen. vern., in demselben Sinn differieren die Werte der kleinasiatischen Population um rund 1%. An sich ist jedoch der Mittelwert der untersuchten kleinasiatischen Frühjahrstiere noch niederer als derjenige der unterfränkischen Sommertiere, wodurch sich diese räumlich weit getrennten Populationen bereits in der ersten Generation wesentlich unterscheiden. Den höchsten Wert erreichen die Falter einer einbrütigen nordtiroler Population, während einbrütige oberbayerische Falter denselben Wert wie die unterfränkischen ergaben.

Ein besonders wesentliches Merkmal ist die Länge der Schwanzspitzen an den Hinterflügeln, worauf von allen Autoren hingewiesen wurde, ohne dasz bisher exakte Messungen vorliegen. Wie verschieden diese bei den beiden Generationen der untersuchten unterfränkischen Population ausgebildet sind und wie genau ihre Variabilität der binomialen Verteilung folgt, zeigt die graphische Darstellung (Abb.2). Die Falter der 2. Generation zeichnen sich gegenüber denen der 1. Generation durch ganz wesentlich längere Schwanzspitzen aus, die Variationsbreiten überschneiden sich nur in einem verhältnismässig kleinen Bereich.

Während die relative Spannweite anscheinend von äusseren Einflüssen weitgehend unabhängig ist, scheint die Schwanzlänge modifizierbar zu sein (Tabelle 2), denn die Falter der 2.Generation des nasskalten Sommers 1948 weisen eine relative Schwanzlänge auf, deren Mittelwert zwischen dem der 1. und dem der durchschnittlichen 2.Generation steht. Auch hier zeichnen sich gebietsmässige Unterschiede ab. Die kleinasiatische Population zeigt wesentlich längere Schwanzspitzen, die bereits in der 1.Generation in Erscheinung treten, aber besonders für die 2.Generation charakteristisch sind. Dem gegenüber sind die Schwanzspitzen der einbrütigen nordtiroler Falter ganz besonders kurz.

Die geschilderten Werte stellen nur einen kurzen Ausschnitt aus den bereits vorliegenden Ergebnissen dar. Sie zeigen die Brauchbarkeit der verwendeten Methode, doch stehen die Untersuchungen erst am Anfang. Es müssen Freilandserien von weiteren Fundorten verglichen und weitere Merkmale herangezogen werden, ausserdem ist die Modifikabilität im Versuch zu prüfen. Schliesslich sind die Untersuchungen auf andere Arten auszudehnen. Alle diese Fragestellungen sind teils in Bearbeitung, teils für die nächste Zeit vorgesehen. Eine genaue Darstellung der umfangreichen Tatsachen und ihrer Folgerungen wird später ausführlich gegeben werden.

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PARTICULARITES DU THORAX DE NICOLETIA
(Apterygotes Thysanoures)

par
J. BARLET
Belgique

Nicoletia est un genre de Lépismatides qui paraît présenter assez bien de caractères primitifs. On pourrait citer à ce sujet les remarques de divers auteurs à partir de GRASSI (1889). HAASE (1889, p.347) n'hésita pas à écrire que ce genre est situé, en quelque sorte, entre *Campodea* et *Machilis*. Beaucoup plus récemment EWING (1942), s'il ne considère pas les Nicolétiines comme les plus primitifs de tous les Lépismes, les fait cependant venir d'une souche plus ancienne que celle des Lépismatines *).

Les auteurs semblent ne s'être guère occupés jusqu'ici du thorax qui est cependant fort intéressant du fait que ses segments, très homonomes et pas plus élargis que ceux de l'abdomen, ne portent pas de lames sous-sternales **). Grâce à cela, *Nicoletia* conserve chez l'adulte les apparences d'un *Lepisma* venant d'éclore.

En examinant les segments thoraciques de *Nicoletia* ***) par la face ventrale, j'ai trouvé – vu l'absence de lames sous-sternales – le furcisternite et surtout le basisternite bien plus ostensiblement en relation avec les anneaux supracoxaux qu'ils ne pourraient l'être chez un *Lepisma*. Le contact entre le sternum et la région pleurale s'établit presque aussi largement que chez certains Collemboles. De plus, le prosternum n'est pas sans évoquer celui des Machilides. Dans ces conditions, je pouvais me demander si, à l'intérieur du corps, les formations endosternales ne présenteraient pas également certains caractères observés dans les deux groupes d'Aptérygotes précités. Cette supposition s'est révélée exacte en ce qui concerne le prothorax.

Si nous considérons en effet la première des deux figures (pag.170) celle relative à l'endosternite prothoracique de *Nicoletia*, nous voyons aussitôt qu'il est moins unifié sur la ligne médiane que celui de *Lepisma* représenté par la seconde figure. L'aspect général diffère et aussi trois particularités qui sont intéressantes.

A noter d'abord la grande fenêtre triangulaire qui s'ouvre dans la région médiane impaire unissant les éléments antéro-latéraux ou „furcaux" (autour de *g*) de l'endosternite à sa région postérieure ou „spinale" (*s*). Nous ne trouvons rien de tel chez les Lépismatines, mais une fenêtre semblable a été vue au prothorax et même au mésothorax des Machilides (CARPENTIER, 1946, fig. 5 et 6).

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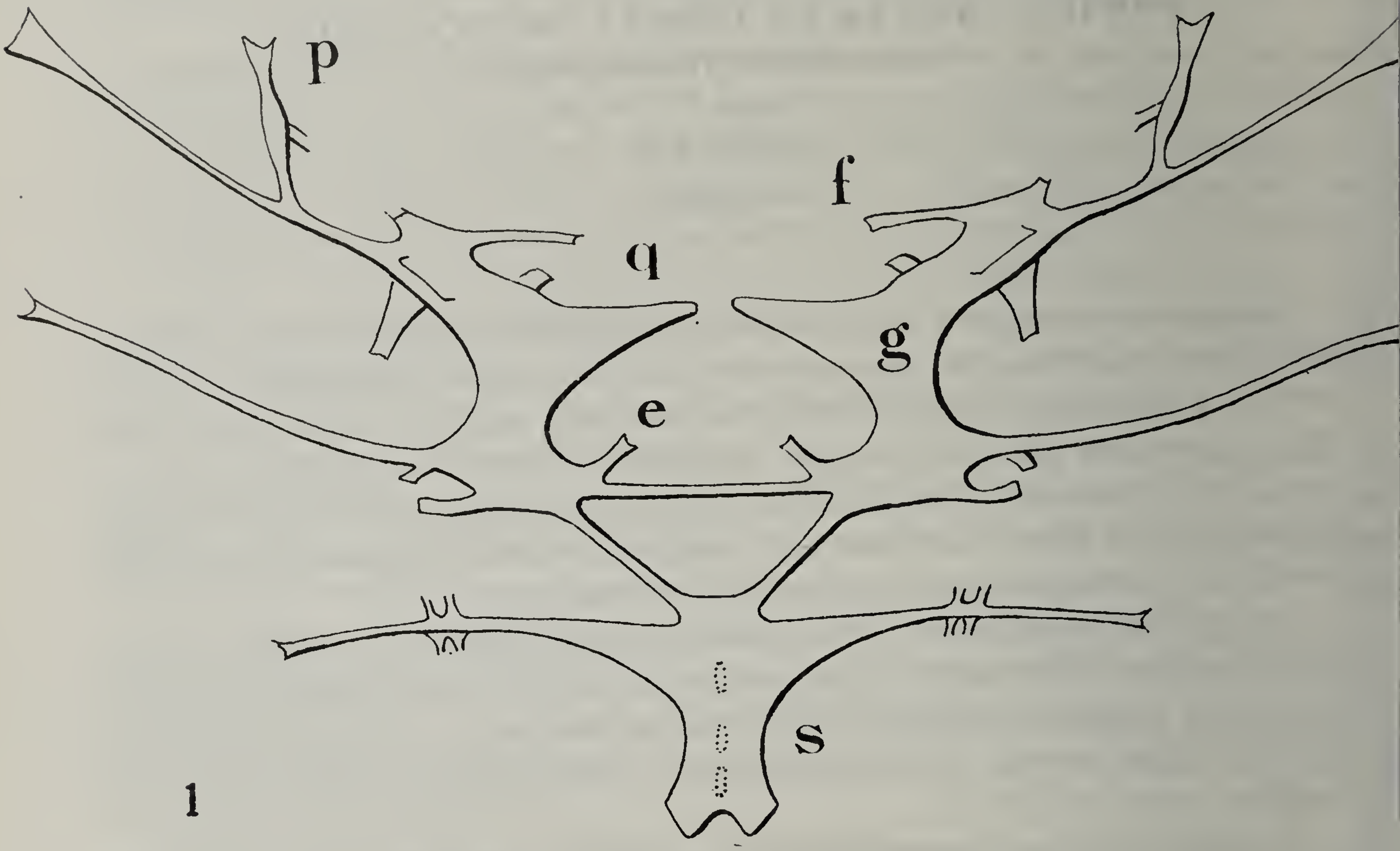
*) Voyez son arbre généalogique, p. 90.

**) Contrairement à ce qu'a ecrit DENIS, 1949, p.253, les lames sous-sternales peuvent donc manquer chez les Lépismatides.

***) *Nicoletia neotropicalis* Silv., spécimens aimablement procurés par le savant systématicien des Aptérygotes, P. WYGODZINSKY (Tucumán, R. Argentine).



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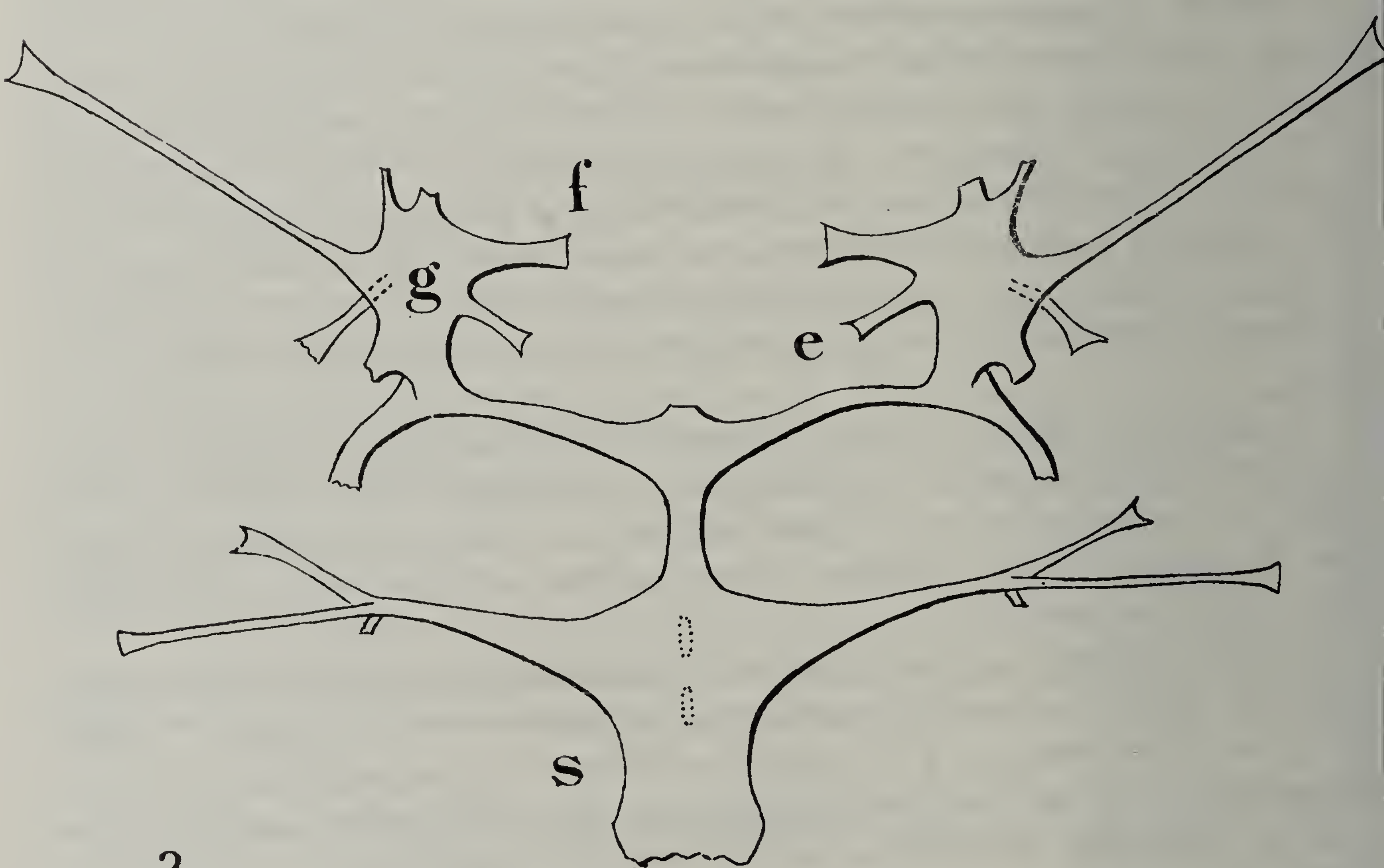

2

Fig. 1 - Endosternite prothoracique de *Nicoletia*. Fig. 2 - Idem de *Lepisma*.
Les lettres sont identiques à celles employées antérieurement par CARPENTIER (1946, 1949) et moi-même (1951). N'ont été réutilisées cependant que celles aidant à comprendre le présent texte.

Deuxièmement, l'endosternite prothoracique des *Nicoletia* se distingue par la possession, en dépendance de ses éléments „furcaux", de deux attaches sternales *(q)* largement triangulaires qui passent sous les ganglions nerveux: rien de semblable n'existe non plus, à ma connaissance, dans le thorax des Lépismatines. Mais des tigelles certainement homologues ont été vues au métathorax de certains Machilides (CARPENTIER, 1949, fig.1), dans les méso- et métathorax de certains Collemboles (ibid., fig.5) et dans l'abdomen de *Lepisma* (BARLET, 1951, fig.1).

Enfin, troisièmement, *Nicoletia* possède, seul parmi les Lépismatides étudiés jusqu'ici, la tigelle pleurale *p* décrite et figurée d'abord au prothorax des Machilides (CARPENTIER, 1946, fig.5), homologuée aux „fourreaux" méso- et métathoraciques des mêmes Aptérygotes, retrouvée ensuite sous une autre forme en divers segments thoraciques de Collemboles (CARPENTIER, 1949, fig.3 et 5) et d'un Campodé (CARPENTIER et BARLET, 1951, fig.2).

A considérer le mode de construction de son endosternite prothoracique, *Nicoletia* se présente donc comme un Lépismatide assez équivoque, associant à des caractères de Lépismes des particularités que semblaient jusqu'ici propres à d'autres groupes d'Aptérygotes considérés comme nettement isolés des Lépismes et à caractères aussi plus primitifs.

Il faut signaler cependant qu'en étudiant les endosternites méso- et métathoracique de *Nicoletia*, je les ai trouvés beaucoup moins differents de leurs correspondants chez les Lépismes ordinaires. Un exosquelette resté d'aspect relativement archaïque peut donc quand même envelopper des formations chitineuses plus évoluées ou probablement telles: car, après tout, il est difficile d'en juger encore avec une entière certitude. Une concordance plus stricte peut apparaître par la suite, mais alors sous une forme plus subtile. Pour la percevoir, il faudra se mettre à analyser d'autres cas aussi variés et aussi nombreux que possible. Un espoir subsiste de pouvoir récolter ainsi de nouveaux éléments d'appréciation des relations qui existent entre les divers groupes d'Aptérygotes.

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BEMERKUNGEN ZU PIERIDENZUCHTEN 1950-1951

von
Gerhard HESSELBARTH
Diepholz, Deutschland

Durch die eingehende und überaus anregende Monographie über *Pieris bryoniae* O. und *Pieris napi* L. von MÜLLER und KAUTZ (1938) wurde ich erstmalig auf die mit diesen Pieriden zusammenhängenden Probleme aufmerksam gemacht. Seit einigen Jahren habe ich nun einige Zuchten durchgeführt, deren bis jetzt wichtigste Ergebnisse im folgenden kurz dargestellt werden sollen.

Als Ausgangsmaterial wurden verwendet:

1. *Pieris napi napi* L. aus NW-Deutschland (Gegend von Diepholz). In normalen Jahren ist *napi* bei uns zweibrütig mit einer partiellen dritten Generation; doch findet sich bei allen drei Generationen ein schwankender Prozentsatz von Puppen mit latenter Entwicklung, die erst im darauffolgenden Jahre die Falter ergeben. In diesem Jahre dürfte die dritte Generation entweder ganz ausfallen oder nur sehr schwach auftreten, da bereits die Frühlingsgeneration etwa 14 Tage später erschien.

2. *Pieris bryoniae bryoniae* O. vom Erstfelderthal, südöstlich Luzern (Schweiz) und vom „Iseler", 1500-1700 m, bei Oberstdorf/Allgäu. Es handelt sich hierbei also um die stets einbrütige ssp. *bryoniae* O., die in den höheren Lagen der Alpen von Ende Mai bis Ende Juli – je nach Witterung – fliegt. Die ♀♀ dieser ssp. sind dunkler als die der mehrbrütig veranlagten ssp. *flavescens* Wagner aus der Umgebung von Wien und die der in den Südalpen (Karawanken) fliegenden ssp. *neo-bryoniae* Shelj. Diese beiden mehrbrütigen ssp. finden sich in tieferen Lagen von etwa 250 m (z.B. Mödling bei Wien) bis etwa 600 m (z.B. Kärntner Rosental).

3. *Pieris napi britannica* Vty. var. *hibernica* Schmidt aus englischen Zuchten. Wie vielleicht nicht allgemein bekannt sein könnte, stammt diese zitronengelbe Form von irischen Freilandtieren aus der Gegend von Donegal ab und ist durch jahrelange Auswahlzuchten von H. W. HEAD (1939) rein herausgezüchtet worden. Sie kommt also in dieser Form in der freien Natur nicht vor.

Von den Paarungen dieser Tiere untereinander werden die folgenden Zuchten herausgegriffen und kurz erläutert:

1. *Pieris bryoniae* ♂ x *Pieris napi* ♀

20 Puppen wurden im Mai 1950 erhalten, von denen die einzige gesunde von grüner Farbe noch im Juni 1950 ein ♂ ergab, das dem *bryoniae-flavescens*-Typus ähnelt. Die Mehrzahl der Puppen mit latenter Entwicklung entliess im Mai 1951 die Falter mit deutlich intermediärem Charakter der weiblichen Tiere (Abb. 1); vor dem Schlüpfen zeigten die Flügelscheiden der weiblichen Puppen eine weit blassere Orangefärbung als die von *bryoniae*-Formen.

Die Nachzucht (F_2) misslang trotz erfolgter Paarung; keines der teilweise befruchteten Eier brachte Räupchen hervor. Obwohl Unterschiede der männlichen Genitalien nicht festgestellt wurden (DROSIHN, 1933, p. 62-63. MÜLLER & KAUTZ, 1938, p. 161-162) und obwohl der Artbegriff recht umstritten ist, neige ich mit KAUTZ und im Gegensatz zu PETERSEN (1947, p. 363-364) zu der Ansicht, dass *napi* und *bryoniae* zwei schon getrennte Arten („bonae species") sind. Freilandbeobachtungen an den Flugplätzen und die Tatsache, dass diese beiden Pieriden sich in der Gefangenschaft nur widerstrebend paaren, unterstützen, glaube ich, meine Auffassung. Dabei möchte ich kein zu grosses Gewicht auf die unfruchtbar gebliebene F_2-Generation legen, da nach meinen Erfahrungen die Pieriden der *napi*-Gruppe sowieso gegen Inzucht empfindlich sind.

2. *Pieris napi hibernica* ♂ x *Pieris napi* ♀

Diese Paarung hatte nach den mir aus der Literatur bekannten Berichten (z.B. FORD, 1938, p. 207) kein überraschendes Ergebnis: sämtliche Tiere der F_1-Generation glichen äusserlich der typischen *napi* mit einer bei *hibernica* häufigen Tendenz zur confluens-Zeichnung (Abb. 2). Die aus überwinterten Puppen im Mai 1951 erzielte Paarung (F_2) ergab 33 Puppen, von denen nur drei die Falter vom *napi*-Typus nach kurzer Puppenruhe ergaben. Das Endergebnis im Frühjahr 1952 dürfte dem früherer britischer Versuche (z.B. SHEPHERD, 1942) gleichen, d.h. die rezessive *hibernica* dürfte nur im 3: 1- Verhältnis auftreten.

3. *Pieris napi hibernica* x *Pieris bryoniae*

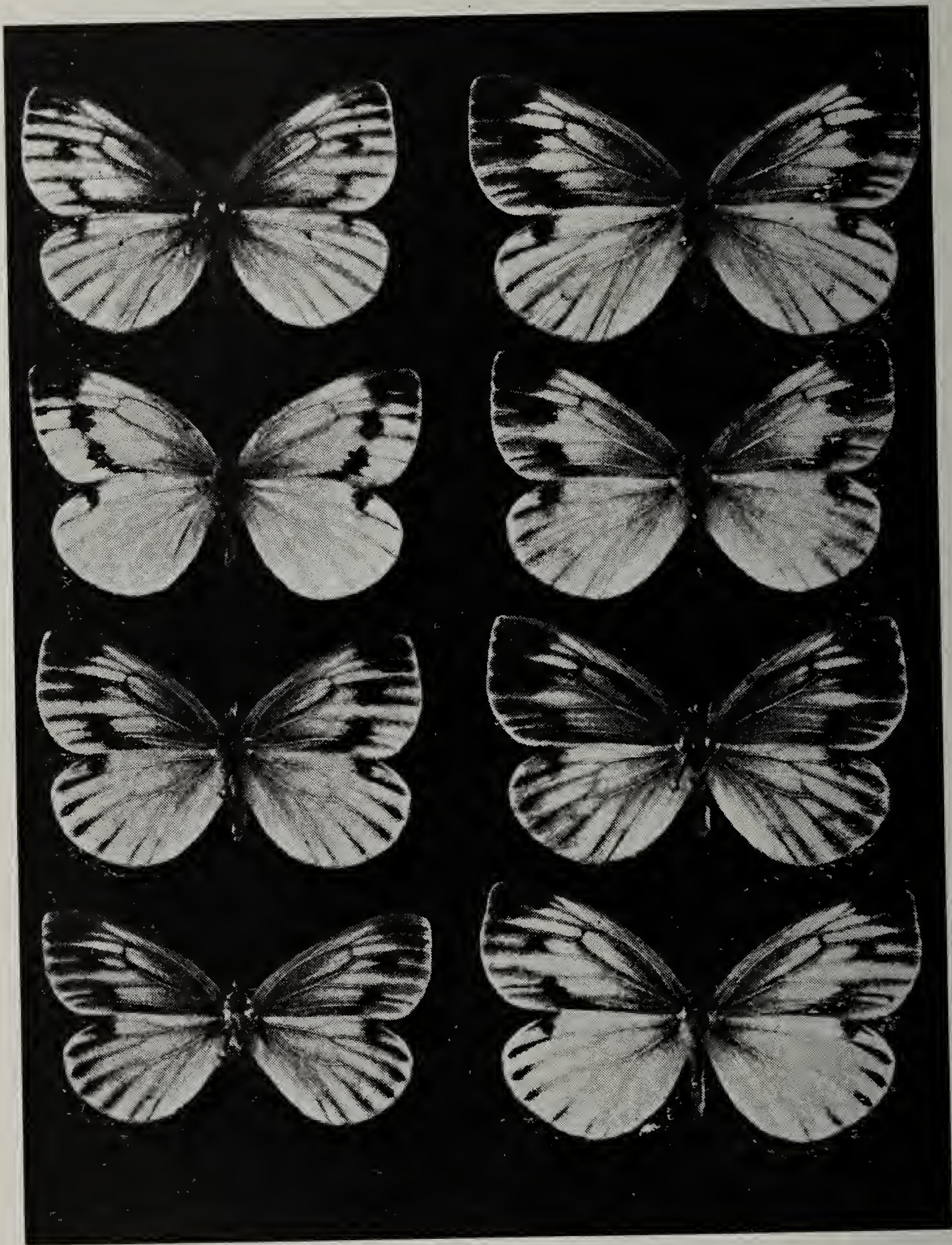
Ergebnisse solcher Kreuzungen sind meines Wissens bisher nicht veröffentlicht worden und dürften daher besonderes Interesse haben. Zwei solcher Paarungen wurden mit Erfolg versucht:

a. *bryoniae* ♂ x *hibernica* ♀

42 Puppen brachten 35 Falter, 3 Puppen überlagen. *P. hibernica*-Tiere traten nicht auf. Die männlichen Falter ähnelten der ssp. *flavescens*, jedoch sind die Adern der Hinterflügel-Unterseite stärker bestäubt als die bei der Sommergeneration von *flavescens*. Die weiblichen Tiere sind kräftiger gelb gefärbt als durchschnittliche *flavescens*, ebenfalls auf der Hinterflügel-Unterseite stärker dunkel bestäubt bei leuchtenderer Grundfarbe (Abb. 3). Die 3 überliegenden Puppen ergaben im Mai 1951 3 ♀♀ vom *radiata*-Typus (Abb. 4).

b. *hibernica* ♂ x *bryoniae* ♀

Diese Zucht (1951) verlief aussergewöhnlich erfolgreich. 180 Puppen wurden gezählt, von denen die gesunden bis auf 62 die zweite Generation ergaben. Die ♂♂ sind von denen der Zucht 3a nicht wesentlich verschieden, während bei den ♀♀ die Zahl derer überwiegt, die bei dunkler Färbung und Tendenz zur ab. *posteromaculata*-Zeichnung (Abb. 5) einen auffällig zitronengelben Unterton tragen, der bei der reziproken Paarung (3a) nicht festzustellen war. Insofern lässt sich dieses Ergebnis mit dem von SHEPHERD (1942) vergleichen, der bei der Paarung *hibernica* x *napi* aus N.Irland auch *hibernica*-gelblich tingierte Nachkommen erzielte.



phot. W.Harstrick, Diepholz

Alle abgebildeten Tiere sind ♀♀.

Linke Reihe, von oben nach Unten:
Abb. 1 : *bryoniae* ♂ x *napi* ♀
Abb. 2 : *hibernica* ♂ x *napi* ♀
Abb. 3 : *bryoniae* ♂ x *hibernica* ♀ (gen. aest.)
Abb. 4 : *bryoniae* ♂ x *hibernica* ♀ (gen. vern.)

Rechte Reihe, von oben nach unten:
Abb. 5 : *hibernica* ♂ x *bryoniae* ♀
Abb. 6 : (*bryoniae* ♂ x *hibernica* ♀) ♂ x (*hibernica* ♂ x *napi* ♀) ♀
Abb. 7 : *bryoniae* ♂ x *bryoniae* ♀ (gen. aest.)
Abb. 8 : *bryoniae* ssp. *flavescens*.

Die hohe Fruchtbarkeit beider Versuche (3a + b) und diese auffällige Färbung bei 3b legen mir die Ansicht nahe, dass *bryoniae* und *hibernica* sich näherstehen als *bryoniae* und *napi*. Leider misslangen die Bemühungen, eine F_2- Generation zu erhalten.

4. (*bryoniae* ♂ x *hibernica* ♀) ♂ (= Versuch 3a) x (*hibernica* ♂ x *napi* ♀) ♀ (= Versuch 2)

Dieser Versuch hinterliess leider nur 13 lebende Puppen, von denen 11 noch eine dritte Generation im gleichen Jahr (1950) ergaben. Mehr oder weniger gleichen dem *napi*-Typus 3 ♂♂ und 2 ♀♀, dem *bryoniae*-Typus 3 ♀♀, dem *hibernica*-Typus 2 ♂♂. Die *bryoniae*-ähnlichen ♀♀ (Abb. 6) zeigen in Färbungs- und Zeichnungsanlage die grösste Variationsbreite, doch ist die für *bryoniae* charakteristische Grundfarbe weiter aufgehellt, wie häufiger bei den *neobryoniae*-Tieren der Südalpen.

5. *bryoniae* ♂ x *bryoniae* ♀

Die blutsfremden Eltern dieser Zucht stammten aus Puppen, die schon im Flachland erzogen wurden. Über 50% der Puppen ergab die 2 Generation (Juli 1951), was auf die veränderten Umweltbedingungen durch 2 Generationen hindurch zurückgeführt werden muss. WEISMANN (1895, p. 20-25) hatte mit seinen Temperaturversuchen die erblich bedingte Einbrütigkeit nicht brechen können, von einzelnen Ausnahmefällen, bei denen es sich vielleicht um eingeschleppte *napi* handelte, abgesehen. Äusserlich nähern sich diese in der Ebene mehrbrütig gewordenen *bryoniae*-♀♀ (Abb. 7) zwar dem *flavescens*-Typus (Abb. 8), doch sind sie deutlich kräftiger gezeichnet und dunkler gefärbt.

Als vorläufige Ergebnisse dieser Pieridenzuchten glaube ich zusammenfassend folgendes herausstellen zu können:

1. *P. napi* und *P. bryoniae* sind getrennte Arten.
2. *P. napi hibernica* steht *bryoniae* näher als die typische *napi*.
3. Die Anlage zur Ein- bzw. Mehrbrütigkeit ist zwar erblich fixiert, jedoch durch die Umwelt schnell beeinflussbar. Inzucht fördert die Anlage zur Einbrütigkeit. Daher mag es vorwiegend einbrütige, isoliert lebende Populationen geben, selbst da, wo die klimatischen Verhältnisse mehrere Bruten gestatteten.

In diesem letzterwähnten Zusammenhang dürfte es interessant und aufschlussreich sein, die Frage zu untersuchen, wodurch die in der Literatur (KLOTS, 1951, p. 201-202) erwähnte Einbrütigkeit der nordamerikanischen *Pieris virginiensis* Edw. bedingt ist und ob sie durch ähnliche Versuche gebrochen werden kann.

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DISCUSSION

Mr. **Roepke**: Fragt ob *napi* und *bryoniae*, sowie die Hybriden, cytologisch untersucht sind und ob sie normal fruchtbar sind.

Mr. **Hesselbarth**: Cytologie wahrscheinlich von FEDERLEY untersucht, die Fruchtbarkeit der Hybride unterliegt grossen Schwankungen, ohne dass hierfür cytologische Ursachen nachweisbar sind (LORKOVIČ).

Mr. **Lorkovič**: Es ist interessant, dass *britanica* rezessiv gegenüber *napi* ist, während meine Versuche gezeigt haben, dass *bryoniae* dominant über *napi* ist, aber nur was die Zeichnung anbetrifft. Die Färbung wird intermediär vererbt.

EIN NEUES EINBETTUNGSMITTEL FÜR KLEINE INSEKTEN, INSBESONDERE FÜR BLATTLÄUSE

von

KURT HEINZE

Berlin-Dahlem, Deutschland

Für die Präparation von Blattläusen sind im wesentlichen zwei Methoden – wenn auch mitunter mit Abwandlungen – in Gebrauch, die von HILLE RIS LAMBERS *) vor kurzem neu beschriebene und etwas modifizierte Methode nach ROEPKE und die von BÖRNER **) bekannt gegebene Methode. Der wesentliche Unterschied zwischen beiden Methoden ist der, dass BÖRNER die Blattläuse möglichst bald nach dem Abtöten entfettet und später mit hochprozentiger Kalilauge durchsichtig macht, während HILLE RIS LAMBERS niedrig prozentige Kalilauge verwendet und anschliessend durch Aufkochen in Chloralhydrat-Phenolgemisch aufhellt. Die entgültige Einbettung wird bei beiden Methoden in Berlesegemisch oder einem Einbettungsmittel ähnlicher Zusammensetzung vorgenommen. Da bei meinen Präparationen, die ich im wesentlichen nach der Börnerschen Methode ausführte, wiederholt Kristallbildung und Verpilzung auf den Objektträgern auftrat, suchte ich nach einem Einbettungsmittel, mit dem sich störende Produkte im Präparat vermeiden lassen. Herr Prof. ZACHER machte mich auf eine Notiz aufmerksam, in der ein zunächst mit Alkohol anzusetzender Polyvinylalkohol zur Einbettung von Milben empfohlen wurde. Polyvinylalkohole sind Verbindungen von grosser Vielseitigkeit. Auf meine Bitte hin stellte mir die Firma WACKER, München, Polyviol W 28/02 zur Verfügung, von der Firma BAYER, Leverkusen, bekam ich einen Polyvinylalkohol mit der Bezeichnung S 70. Beide Polyvinylalkohole sind wasserlöslich. Ich probierte verschiedene Mischungen der Polyvinylalkohole mit anderen Stoffen durch und fand folgende Zusammenstellung brauchbar.

10 g Polyvinylalkohol
35 ccm Milchsäure
25 ccm Phenol (15%)
10 ccm Glyzerin
20 g Chloralhydrat
40-60 ccm aqua dest.

Dieses von mir als Polyvinylalkohol-Lactophenolgemisch bezeichnete Einbettungsmittel wird auf folgende Weise hergestellt:

Der Polyvinylalkohol wird durch allmähliches Zugeben des Pulvers in aqua dest. zu einer breiigen Masse angerührt und anschliessend, um die Lösung zu

*) Entom. Berichten 13: 55-58, 1950.

**) Veröffentl. Dtsch. Kolonial u. Überseemus. Bremen 3: 267-272, 1942. Nachrichtenbl. Dtsch. Pflanzenschutzd. (Berlin) N.F. 6: 101-111, 1951.

beschleunigen, im Wasserbad erhitzt. Dann wird unter Rühren die Milchsäure hinzugegeben, anschliessend das Glyzerin, zum Schluss wird das im Phenol gelöste Chloralhydrat in dem Gemisch verrührt. Für eine bessere Mischung und zur Lösung der letzten Chloralhydratreste bringt man das Gemisch für einen Tag in eine Schüttelapparatur. Danach wird durch Glaswolle filtriert. Ist das Gemisch etwas zu flüssig, so kann im Wärmeschrank später wieder eingedickt werden. Für die Einbettung in Polyvinylalkohol-Lactophenolgemisch bleibt die Vorbehandlung der Aphiden (Auskochen in Kalilauge, Aufquellen in aqua dest.) die gleiche. Die Objekte können aus aqua dest. direkt in das Gemisch übergeführt werden. Es ist reichlich Einbettungsmittel zu nehmen. Die mit Einbettungsmittel bestrichenen Deckgläschen werden erst nach ein bis zwei Tagen aufgelegt, damit sich die Objekte nicht mehr verschieben können. Bewährt hat sich, die Deckgläschen nach ein-zwei Monaten mit Caedax (von BAYER, Leverkusen) zu umranden.

Die Vorteile dieses Einbettungsmittels sind die, dass sich Borsten, Strukturen der Kutikula, Rhinarien usw. sehr klar und scharf abheben, und dass das Mittel pilzbeständig ist.

Da ich oft Klagen von Kustoden an Museen, dass sich die Berlese-Präparate über längere Zeiträume schlecht halten, empfing, prüfte ich die Verwendbarkeit von Caedax zur Einbettung von Aphiden. Die Einbettung ungefärbter Objekte war unbefriedigend. Nur sehr massive Borsten oder stark chitinisierte oder natürlicherweise gefärbte blieben sichtbar. Es wurde deshalb zusätzlich mit Kongorot gefärbt und über 96%igen Alkohol und Kreosot direkt in Caedax eingebettet. Trotz der Kongorotanfärbung befriedigten mich die erzielten Ergebnisse noch nicht. Ich wandte mich deshalb an die BAYER-Werke wegen eines anderen Farbstoffes und bekam zur Anfärbung des Chitins eine Probe von Direkttiefschwarz, das das Chitin wesentlich besser anfärbt als Kongorot und zwar grünlichblau. Von dem Farbstoff werden 0.025 g in 50 ccm 96%igen Alkohol gelöst. Die Objekte kommen nach dem Auskochen und dem Fertigpräparieren in aqua dest. etwa 10 Min. in eine schwachprozentige Salzsäurelösung, anschliessend in aqua dest. in 78%igen Alkohol, in die Farblösung für 1-2 Stunden, etwa 5 Min. in Alkohol 96%, die gleiche Zeit in Kreosot und können anschliessend in Caedax eingebettet werden. Ein Teil dieser Behandlungsschritte kann auf dem Objektträger vor sich gehen. Die Einzelheiten der Chitinhülle, auch die Borsten, kommen bei dieser Behandlungsweise recht gut heraus, sind aber nicht mit der hervorragenden Polyvinylalkohol-Lactophenol-Einbettung zu vergleichen. Wenn aber für museale Zwecke auf Caedax, oder Kanadabalsam-Einbettung unbedingt Wert gelegt wird, sollte die Anfärbung mit Direkttiefschwarz vorgenommen werden, damit man von den systematisch wichtigen Borsten überhaupt noch etwas erkennt. Bei Polyvinylalkohol-Lactophenol-Einbettung soll nicht angefärbt werden, damit die natürlichen Farben nicht überdeckt werden.

Ich hatte die Hoffnung, mit Hilfe des Phasenkontrastmikroskopes auch die Borsten in Caedax besser sichtbar machen zu können. Was ich bisher in der Beziehung gesehen habe, befriedigte noch nicht. Bei Betrachtung von Blatt-

läusen in Polyvinylalkohol-Lactophenol unter Benützung des Phasenkontrastmikroskopes war das mikroskopische Bild jedoch von unerhörter Brillianz. Wurde beim Zeiss Mikroskop Dunkelfeldbetrachtung mit Grünfilter vor der Beleuchtung gewählt, so erinnerten die Bilder an Objekte, die mit Fluoreszenzfarben angefärbt wurden. Leuchtend grün standen die Borsten und andere Chitinteilte im matten Blickfeld.

Die Polyvinylalkohol-Lactophenol-Einbettung hat sich auch für die Präparation anderer kleiner Insekten bewährt. Neben Thysanopteren, Milben, kleinen Spinnen, die mit Kalilauge vorbehandelt wurden, gaben alle nicht zu stark chitinisierten und undurchsichtigen Insekten gute Ergebnisse.

Ich möchte noch einmal zusammenfassen:
Ein Polyvinylalkohol-Lactophenol-Gemisch mit 10 g Polyvinylalkohol (Wacker W 28/02, oder Bayer S 70), 35 ccm Milchsäure, 25 ccm Phenol (15%), 10 ccm Glycerin, 20 g Chloralhydrat und 40-60 ccm aqua dest. bringt sehr gute und kontrastreiche Bilder bei der Einbettung vorbehandelter kleiner Insekten, insbesondere bei Blattläusen. Für Caedax (oder Kanadabalsam)-Präparate empfiehlt sich die Anfärbung der Objekte mit Direkttiefschwarz, einem Farbstoff für Chitin. Die Bildschärfe von Borsten oder Chitinstrukturen lässt sich durch Betrachtung der in Polyvinyl-Lactophenol eingebetteten Objekte mit dem Phasenkontrast-Mikroskop (Zeiss) oder bei Dunkelfeldbetrachtung noch verbessern.

DISCUSSION

Mr. **Roepke** betont, dass der Schwerpunkt der Einschluss-Methode HILLE RIS LAMBERS und anderer auf der Verwendung von Milchsäure als Mazerationsmittel beruht. Er fragt, ob die Objekte in Polyvinylalkohol nicht schrumpfen, und ob die fertigen Präparate wieder in Wasser usw. gelöst werden können.

Dr. **Heinze**: Keine Schrumpfung beobachtet, ausser wenn technische Fehler gemacht wurden. Wieder-Löslichkeit wahrscheinlich möglich.

DIE ROLLE DER ENTOMOLOGIE IN DER WIENER VOLKSBILDUNG

von

Harald SCHWEIGER

Wien, Österreich *)

Summary

In den letzten Jahren war in der österreichischen Entomologie insoferne eine gefährliche Situation eingetreten, als die vorhandenen wissenschaftlichen Fachvereine durch Überalterung und der damit verbundenen Verminderung des Mitgliederbestandes langsam zugrundezugehen drohten. Damit verschob sich der Schwerpunkt naturgemäss auf die Amateurclubs welche wieder den Nachteil hatten, dass sie zumeist in zahlreiche, kleine Tischgesellschaften zersplittert waren, die ohne fachgemässe Führung ihr Dasein fristeten. Zu allen diesen Schwierigkeiten kam noch das Nachwuchsproblem, welches im ersten Augenblick als unlösbar schien. So drohte die traditionsreiche österreichische Entomologie allmählich auszusterben.

Es war nun klar, dass sich verschiedene jüngere Entomologen dieser Gefahr bewusst waren und alles daran setzten um sie zu bannen. Die erste Initiative ging vom Lepidopterologen RSYZKA aus der unabhängig von allen anderen Bestrebungen im Jahre 1946 an der Volkshochschule Ottakring eine entomologische Fachgruppe einrichtete, die in der Folge vom Leiter der Schule Herrn Univ. Prof. MARINELLI auf das eifrigste gefördert wurde. Anfangs besuchten ganze 12 Hörer diese Kurse. In der Folge sollte jedoch gerade diese Fachgruppe sich als Keimzelle des neuen österreichischen Entomologenverbandes erweisen. Im Winter des folgenden Jahres vereinigte sich diese Fachgruppe mit dem Verein Sphinx, sodass die Anzahl auf etwa 35 Mitglieder stieg.

Im Jahre 1948 wurde es allen Entomologen klar, dass der einzige Ausweg im Zusammenschluss aller noch vorhandenen Vereine bestand. Nach monatelangen Verhandlungen entstand auf diese Weise die Arbeitsgemeinschaft österreichischer Entomologen, die in überraschend kurzer Zeit 80% der österreichischen Entomologen zu ihren Mitgliedern zählen konnte.

Die Organisation der Arbeitsgemeinschaft wurde dabei mit ihrem Schwerpunkt auf die Volkshochschule als Bildungszentrum verlegt. Hier wurden einmal im Monat ein Grossvortrag über Entomologie gehalten, der dem Publikum frei zugänglich war. Ausserdem fanden jeden Samstag Lehrvorträge für Anfänger und Fortgeschrittene staat, die die Hörer mit den wichtigsten Problemen der Biologie vertraut machten um ihnen so die Möglichkeit zum selbstständigen Arbeiten zu geben. Daneben wurden aber auch im Klubheim der Arbeitsgemeinschaft einmal wöchentlich interessante Vorträge von namhaften Wissenschaftlern gehalten. Für die Propaganda wurden Rundfunk und

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Presse eingesetzt und so weiteste Kreise für die Entomologie gewonnen. Wie sehr sich diese Methoden bewärten, zeigt die Tatsache, dass die Gesellschaft gegenwärtig über 250 Mitglieder in Österreich besitzt und jede Woche bis zu drei Neubeitritte zu verzeichnen sind.

In den letzten zwei Jahren wurde je eine Entomologentagung in Wien abgehalten auf der neben Fachvorträgen auch eine grosse Insektenausstellung zu sehen war. Durch die Förderung seitens verschiedener staatlicher Stellen ist es nun möglich im kommenden Herbst eine entomologische Wanderschau zu veranstalten, die für die Gesellschaft werben soll.

Zur Lösung des Nachwuchsproblems wurde im Einvernehmen mit dem Wiener Stadtschulrat an der Volkshochschule Ottakring im heurigen Frühjahr eine Jungentomologengruppe errichtet, die bereits über 50 Mitglieder besitzt und in einer Schule Entomologie als Freifach eingeführt. An zwei weiteren Volkshochschulen wurden ebenfalls Entomologengruppen eingerichtet und im kommenden Herbst ist noch eine Intensivierung der Kurse geplant.

NOTA SOBRE LA ESPECIE AËDES (OCHLEROTATUS) MILLERI DYAR, 1922, ENCONTRADA EN CUENCA (AZUAY), ECUADOR, CON LA REDESCRIPCION COMPLETA DE LA ESPECIE (DIPTERA – CULICIDAE)

por

Roberto LEVI-CASTILLO
Guayaquil, Ecuador

Esta especie ha sido hallada por el autor en las márgenes del rio Tomebamba, junto al puente llamado de la "Escalinata" en la ciudad de Cuenca (Ecuador, Provincia del Azuay) a una altura de 2.600 mts. sobre el nivel del mar. Los criaderos de esta especie son pozas de agua clara con un pH de 6.8 y una temperatura media de 18° C, con abundantes algas Spyrogirae y con el fondo limoso de tipo calcareo-cretoso. El adulto vuela hacia las casas, entrando atraido por la luz, picando al hombre y a los animales, depositase sobre las paredes de las casas y es muy abundante en la región.

Aëdes (Ochlerotatus) milleri Dyar 1922 [1)]

Larva

Cabeza redondeada. Antena larga con un penacho ramificado en la mitad, el cuerpo se encuentra espiculado, termina con dos sables medianos y puntiagudos. Pelo ante-antenal formado por cuatro elementos; pelo anterior dorsal doble o triple; pelo mediano dorsal doble o triple.

Sifón de aire dos veces y media mas largo que ancho, con un pectén compuesto por 17 a 19 dientecitos de base redonda y punta larga y delgada, seguidos de un penacho de 8 elementos. El peine del octavo segmento abdonimal está compuesto por varios dientecitos alargados y de punta roma, redondeada y finamente espinulada, a ambos lados se observan penachos de 4 elementos y en la parte posterior un penacho compuesto por ocho elementos. El segmento anal es casi cuadrado con la brocha dorsal formada por cuatro elementos largos y fuertes; pelo lateral largo y simple; brocha ventral fuerte y de elementos ramificados.

Pupa

Trompeta mediana, alargada y con abertura casi cuadrangular. El pelo 2 en el I segmento es dendrítico y muy ramificado, en los demás segmentos es largo y simple o doble. Pelo 5 en los segmentos IV al VII largo y doble. Pelo 8 es simple y formando casi una punta córnea en el segmento VII y grande y ramificado en el segmento VIII. Las agallas pupales son grandes redondeadas, de bordes dentados, el pelo terminal es corto y simple, naciendo de una costilla central, que recorre desde su nacimiento cada una de las agallas pupales.

Adulto

Prosbocis larga y revestida de escamitas café-obscuras con moteado de

1) Dyar, H.G. – Ins. Mens. 10: 194, 1922

claras. Los palpos son en la hembra cortos y lobulosos, muy revestidos de pelitos cafés, en el macho son ligeramente mas pequeños que la prosbocis y muy revestidos de pelitos cafés. La cabeza muestra el vértice y el occipucio de coloración café, revestido de escamitas blancas que llegan hasta el borde de los ojos y cerditas doradas y blancas, las que forman un penacho en el vértice, él que avanza sobre el clipeo.

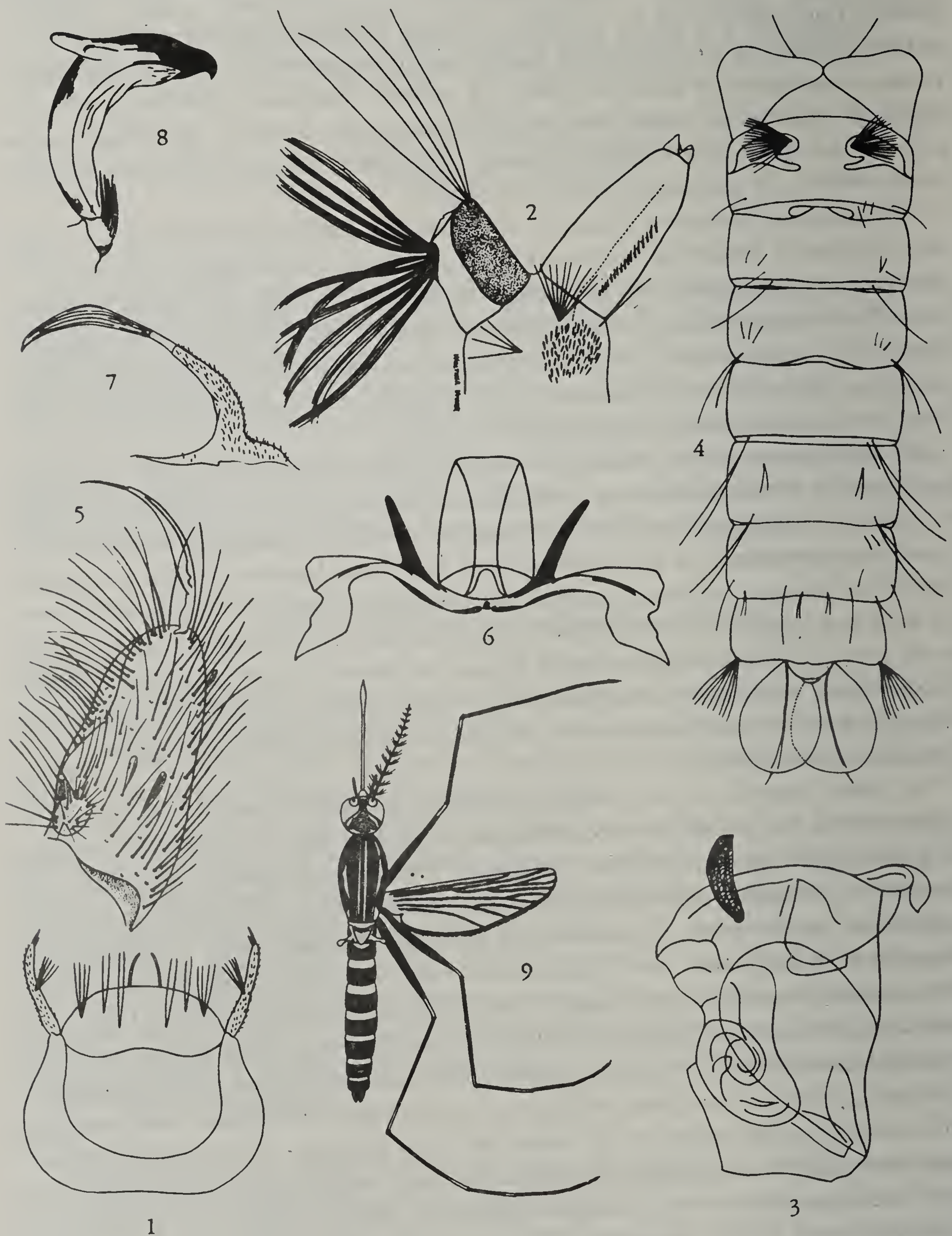
El disco del mesonoto tiene el integumento café, observándose una zona muy obscura y varias zonas centrales mas claras, recorridas por líneas café mas claras y revestidas de escamitas doradas y cerditas blancas y doradas. Los lóbulos protoráxicos son redondos, negros y muy revestidos de cerditas obscuros y manchas de escamitas blancas; el escutelo es café, trilobular y continua los colores del mesonoto; las pleuras son café claras pero se hallan con revestimientos de escamitas blancas..

El abdomen es en la porción dorsal café, pero se halla revestido en la mayor parte de los segmentos de escamitas blancas, las que forman lateralmente anillos completos los que en la porción ventral se amplian formando una linea blanca ventral, la que apenas tiene las zonas basales cafés. Las patas tienen los fémures y tibias formados por escamitas blancas y negras entremezcladas; los segmentos son negros, con punteado de escamitas blancas, siendo la porción distal completamente blanca es decir ¼ y hasta la mitad en los dos últimos segmentos son blancos, en la porción distal. Las alas están revestidas de escamitas obscuras, sin importancia diferencial ninguna.

Terminalia Masculina

La pieza lateral es mas larga que ancha, estando revestida en su superficie externa por múltiples cerdas largas, lo mismo que la superficie interna; el lóbulo basal es mamelonado, redondo y revestido de pelitos pequeños. El clasper es delgado, recurvándose y anchándose subbasalmente para luego angostarse en la punta y terminar en una uña delgada larga y puntiaguda. Mesosoma rectangular, muy quitinisado con la punta plana y los bordes redondeados; los segmentos basales son gruesos y muy quitinosos. Las claspetas son de una base gruesa, recurvada, revestida de pelitos, la que presenta un apéndice en forma de hoja de alfanje turco, que remata en una punta aguda y curvada, con una base muy quitinosa. Los décimos esternitos son gruesos, quitinosos, con un extremo en forma de pico de ave, en su parte interior presentan algunas pequeñas pilosidades y una cerda de base tubercular y de largo mediano. Los novenos térgitos nacen de lóbulos quitinosos y están representados por cuatro elementos filamentosos y de pequeño grosor.

Esta especie es siempre hallada a gran altura sobre el nivel del mar, siendo común en la región interandina del Ecuador. Es la primera vez que se describe la larva, así como también la pupa, siendo ambas nuevas para la ciencia, ya que apenas se habia descrito el adulto incompletamente. No existen ilustraciones sobre esta especie, siendo los esquemas aquí representados los primeros que existen sobre ella.



Aëdes (O.) milleri. Fig. 1 – Cabeza de la larva. Fig. 2 – Porción caudal de la larva. Fig. 3 – Céfalotorax de la pupa. Fig. 4 – Segmentos abdominales de la pupa. Fig. 5 – Coxita. Fig. 6 – Mesosoma. Fig. 7 – Claspeta. Fig. 8 – Décimo esternito y Noveno térgito. Fig. 9 – Representación esquemática del adulto.

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SECTION II

NOMENCLATURE

PROPOSITION D'UNE REGLEMENTATION POUR LA FORMATION DES TERMES SCIENTIFIQUES COMPOSES (choix de la voyelle de liaison)

par
Pierre BONNET
Toulouse, France

Au cours du recensement des 50.000 Araignées décrites dans le Monde entier jusqu'en 1939, animaux qui ont entraîné la création de 200.000 termes différents, j'ai eu l'occasion de noter, dans la formation des noms composés utilisés, de nombreuses irrégularités et surtout une grande indifférence dans le choix de là voyelle de liaison qui unit les deux termes, voyelle qui paraît avoir été utilisée n'importe comment.

J'ai déjà abordé ce sujet dans „Bibliographia Araneorum", 1945, tome 1, p. 123 et dans le „Bulletin of Zoological Nomenclature", tome 3, p. 185; mais me trouvant chaque jour en présence de nouvelles difficultés, j'ai dû revoir cette question pour en faire une meilleure étude et me corriger sur certains points. Aussi je crois pouvoir présenter aujourd'hui une réglementation sérieuse qu'il y aura intérêt à suivre. Je remercie M. MÉQUIGNON pour les remarques judicieuses qu'il m'a faites lorsque je lui ai présenté ce règlement en élaboration.

1. TERMES FORMES D'UN ADJECTIF (OU D'UN MOT ADJECTIVE) PRECEDE D'UN PREFIXE INVARIABLE (PREPOSITION, ADVERBE, ADJECTIF NUMERAL)

Les deux termes s'unissent sans voyelle de liaison, qu'il s'agisse de racines grecques ou latines. (S'il y a une voyelle entre les deux composants, elle appartient à l'un des deux termes, mais ce n'est pas une voyelle de liaison):

pseudosaltuaria, microporus, polydactylus, synanthus, protozoon, monocephalus.
subaequalis, subfasciatus, sexpunctatus, decemnotatus, senoculatus.
seminigra, unicornis, biquadratus, quadrimaculatus, quinqueguttata.

R e m a r q u e. Lorsque le premier terme finit et que le deuxième commence par une voyelle, il y a lieu d'éviter l'hiatus en syncopant toujours la voyelle du préfixe et non celle du second mot:

protoarachne	= *protarachne*	*microaster*	= *micraster*
unioculus	= *unoculus*	*quadriangulatus*	= *quadrangulatus*
pseudoicius	= *pseudicius*	*pseudoagricola*	= *pseudagricola*

quinqueoculatus = *quinquoculatus* et mieux *quinoculatus.*

(microorganisme est incorrect, c'est microrganisme qu'il faut dire).

Cependant l'hiatus subsiste avec les préfixes monosyllabiques (*bi, tri*) ou certains disyllabiques (*semi, poly*), car la suppression de la voyelle entraînerait l'incompréhension du terme: *biimpressum, semiater.*

Les préfixes *pro* et *re* prennent les formes *prod* et *red* devant une voyelle, ce qui supprime automatiquement l'hiatus: *prodigus, redemptus, redimitus.*

2. TERMES FORMES, SOIT DE DEUX ADJECTIFS, SOIT D'UN ADJECTIF AVEC UN SUBSTANTIF OU UN VERBE ADJECTIVE, SOIT D'UN SUBSTANTIF AVEC UN VERBE DEVENU ADJECTIF VERBAL

Il y a lieu de prendre le radical du premier terme et de l'unir au second par une voyelle de liaison: obligatoirement *o* s'il s'agit de racines grecques et *i* s'il s'agit de racines latines:

erythrocephalus, heteropoda, melanognatha, hygrophilus, ...

albimaculatus, nigriventris, rubrifasciata, longistylus, pallidiflava, ...

omnivorus, lucifuga, crucifer, dentiger, herbigrada, floricola, ...

(*erythricephalus, melanipoda, albomandibulata, nigroventris, flavopalpis, longostylus, pallideflava,* . . . . . sont incorrectement formés).

Exceptions: Quelques termes à racines latines, formés avec *o* comme voyelle de liaison, au lieu de *i*, sont à conserver:

α. termes composés de deux noms géographiques:

galloromanus, galloprovincialis, hispanogallicus, . . .

β. termes composés de deux adjectifs exprimant des couleurs:

fuscorufus, fulvonigrum, alboniger, atrocaeruleus, . . .

γ. certains termes composés chez lesquels *o* n'est pas une voyelle de liaison, mais la terminaison normale de l'ablatif appelée par un lien syntaxique normal (ablatif de manière ou de matière):

aurocinctus, auroclavata, aurostriatum, . . .

D'ailleurs, dans ce cas, on peut trouver toutes les désinences des ablatifs latins:

pilistectus, pulveresparsa, maculisparsus (pour *maculissparsus*).

δ. à ce cas se rattache celui des adjectifs de couleur pouvant être pris substantivement: le blanc: *album,* le noir: *nigrum,* le bleu: *caeruleum;* il est normal d'y joindre *fuscus, fulvus, flavus, ater, ruber, luteus, brunneus* (même s'ils n'ont pas en latin de substantifs correspondants) et des adjectifs comme *cinereus, niveus, argenteus.*

albostriatus, nigromaculatus, fuscovittatus, flavocinctus, . . .

luteofasciatus, argenteomaculata, cinereopilosa, niveoguttatus, . . .

C'est dans ce cas que ces termes ont été utilisés avec *i*, conformément à la règle générale, les auteurs n'ayant pas vu la différence entre la voyelle de liaison et le lien syntaxique normal.

albistriatus, nigrimaculatus, fuscivittatus, flavicinctus, . . .

(Voir plus loin la conduite à tenir en pareil cas).

Mais il faut rappeler que si ces adjectifs de couleurs sont suivis d'un substantif, c'est *i* qu'il faut utiliser suivant la règle générale:

albimanus, nigrifrons, luteipes, niveithorax, rubriceps, . . .

(*albomanus, nigrofrons,* . . . seraient fort incorrects).

Remarque: Lorsque le deuxième mot commence par voyelle, il n'est pa

besoin de voyelle de liaison pour unir les deux termes, ce qui évite la formation de l'hiatus:

erythrophthalmus	non *erythroophthalmus;*	*melanodontus*	non *melanoodontus*
nigrolivacea	non *nigroolivacea;*	*fulvaster*	non *fulviaster*
ferrequinus	non *ferriequinus;*	*albirroratus*	non *albiirroratus*

(*Argyroepeira* est mal formé, c'est *Argyrepeira* qu'il aurait fallu dire.)

3. TERMES FORMES DE DEUX SUBSTANTIFS

a. Le premier, complément déterminatif du second, se met au génitif, le deuxième au nominatif:

tauricornu, equisetum, menthaefolia, argentifrons, . . .

b. L'inversion des deux substantifs peut ne pas exister, de ce fait le premier reste au nominatif et le second au génitif:

densleonis, cornucopiae, cornupastoris, . . .

c. Le premier est complément déterminatif du second qui est lui-même complément déterminatif du nom générique; dans ce cas-là ils sont tous les deux au génitif:

olivarummontis, aviuminsulae, . . .

Dans ces trois cas, qu'ils soient utilisés comme mots en apposition (a, b) ou comme déterminatifs (c), ces termes sont invariables, quelque soit le sexe du genre.

d. Le deuxième substantif prend une forme adjective variable; de ce fait, le premier ne peut être au génitif (comme dans a); on prend alors son radical et on l'unit au deuxième par une voyelle de liaison:

fronticornis, e; anguicomus, a, um ; vermiformis, e; formiciformis e; . . .
(et non *frontiscornis, anguiscomus, vermisformis, formicaeformis*).

REMARQUES GENERALES IMPORTANTES

a. *Terminaison du deuxième terme en vue de son accord avec le nom générique*

α) termes adjectivés invariables pour les trois genres avec les mots *pes, frons, thorax, dens, ceps, gaster, color,* ainsi que *vulva* et la forme verbale *cola* (du verbe *colere*, habiter).

Araneus longipes	*Lycosa longipes*	*Theridium longipes*
Araneus cordivulva	*Lycosa cordivulva*	*Theridium cordivulva*
Araneus agricola	*Lycosa agricola*	*Theridium agricola*

(*agricolus* et *agricolum* sont d'affreux barbarismes).

β) termes adjectives en *us, a, um: manus, carpus, acanthus, capillus, phthalmus, gnathus, stylus, scapus, lithus, cyclus, typus, florus,* etc. . *spina, cauda, coma, gramma, furca, lingua,* etc. . . aussi *tarsus, palpus, barbus, jugus* (qui peuvent apparternir au cas suivant) et les formes verbales *genus, fugus, vorus, gradus, vagus, phorus, philus:*

Araneus longimanus	*Lycosa longimana*	*Theridium longimanum*

Araneus brevispinus	*Lycosa brevispina*	*Theridium brevispinum*
Araneus nigritarsus	*Lycosa nigritarsa*	*Theridium nigritarsum*
Araneus lucifugus	*Lycosa lucifuga*	*Theridium lucifugum.*

Parfois le masculin peut être irrégulier à la façon de *pulcher, pulchra, pulchrum*, comme, par exemple, *aster* et les formes verbales *fer* et *ger*:

Araneus fulvaster	*Lycosa fulvastra*	*Theridium fulvastrum*
Araneus crucifer	*Lycosa crucifera*	*Theridium cruciferum*
Araneus spiniger	*Lycosa spinigera*	*Theridium spinigerum*

(*cruciferus* et *spinigerus* sont des barbarismes).

γ) termes adjectivés en *is, e* (*is* pour le masculin et le féminin, *e* pour le neutre) avec les mots *cornis, setis, ventris, sternis, rostris, chelis, collis, formis, montis*, etc. . . et aussi *tarsis, palpis, barbis, jugis, linguis*:

Araneus longicornis	*Lycosa longicornis*	*Theridium longicorne*
Araneus dentichelis	*Lycosa dentichelis*	*Theridium dentichele*

(Pour les termes supportant les deux sortes de terminaison, *tarsus tarsis, palpus palpis, barbus barbis, linguus linguis, jugus jugis)* il est préférable d'employer les formes en *is*.)

b. *Termes hybrides.* On ne doit pas créer de termes formés à la fois d'une racine grecque et d'une racine latine; des termes comme:

tetralineatus, nigrocephalus, isopeda, sont incorrects et inadmissibles.

c. *Le radical d'un mot utilisé comme premier terme doit être pris à son cas génitif* (et non au nominatif qui peut être irrégulier):

niger, nigri	radical	*nigr*	*nigritarsis*	et non	*nigeritarsis*
crux, crucis	"	*cruc*	*crucifer*	" "	*cruxifer*
lux, lucis	"	*luc*	*lucifuga*	" "	*luxifuga*
mus, muris	"	*mur*	*murilemur*	" "	*musilemur*
pes, pedis	"	*ped*	*pedisequa*	" "	*pesisequa*
cor, cordis	"	*cord*	*cordiformis*	" "	*coriformis*

De même, lorsque le deuxième mot donne un terme dérivé (pour la formation des noms de groupes notamment) c'est aussi le génitif qui doit être utilisé:

Octopus	doit former	*Octopodidae*	et non	*Octopidae*
Stephanopsis	" "	*Stephanopsididae*	" "	*Stephanopsidae*

Lorsque le nom latin, lui-même dérivé d'un mot grec, a pris un radical différent, c'est le radical du mot grec qui doit être employé:

gaster, gastros a donné en latin *gaster, gasteris*

(radical grec = *gastr*) (radical latin = *gaster*)

il faut donc dire *Gastropoda* et non *Gasteropoda* (qui est hybride); si l'on voulait se servir du radical latin, c'est *Gasteripeda* qu'il faudrait dire.

RÈGLEMENTATION PRATIQUE

Comme de nombreux termes ont été créés contrairement à la réglementation ci-dessus, il paraîtrait absurde aujourd'hui de les corriger tous par seul

souci de régularisation et d'uniformisation; en pareil cas le remède serait pire que le mal. Si pour la création de nouveaux termes, il est sage de tenir compte des règles édictées, il y a lieu pour les termes incorrects déjà créés et utilisés de se comporter de la façon suivante.

a. Lorsque pour un genre ou une espèce, on a employé le terme correct et le terme incorrect (*Isopoda* et *Isopeda, nigriventris* et *nigroventris*, . .) il faut, naturellement, ne se servir à l'avenir que du terme correctement formé (même si le terme incorrect est la graphie originale et le terme correct la graphie rectifiée).

b. Lorsqu'un terme incorrectement formé a toujours été ainsi utilisé, parfois plusieurs centaines de fois, il y a lieu de ne pas le modifier. On doit donc continuer à dire et à écrire *Gasteracantha, Argyroepeira, Argyroneta* qui n'ont jamais été employés que sous ces formes-là, les graphies correctes étant *Gastracantha, Argyrepeira, Argyronecta.* De même pour les termes hybrides, un *nigrocephalus,* employé sous cette forme incorrecte au moins une vingtaine de fois, ne doit pas être changé en *melanocephalus* ou en *nigriceps* qui sont les graphies correctes; c'est pour la même raison qu'on ne saurait modifier aujourd'hui le mot français *automobile:* un long usage finit par régulariser l'incorrection.

c. Mais si un terme incorrectement formé n'a été écrit qu'un petit nombre de fois (jusqu'à 5 ou 6 par exemple), parfois même la seule fois où il a été créé, il convient de le rectifier de la même façon que l'on corrige une faute d'orthographe, d'impression ou de transcription (art. 19 des Règles intern. de Nomenclature). On doit alors changer un *albomanus* en *albimanus* ou un *nigrocephalus* en *nigriceps,* de même que l'on rectifie un *cruciferus* en *crucifer* ou un *flovipalpis* en *flavipalpis.*

d. Enfin dans le cas des mots composés latins chez lesquels l'une et l'autre voyelle de liaison ont été utilisées formant des termes corrects tous les deux: *albimaculatus* et *albomaculatus* (voir cas général 2 et l'exception δ), il y a lieu de respecter la graphie originelle. Toutefois, dans certains cas, si le terme n'a pas encore été très employé, il vaudra mieux se servir du terme le plus euphonique: c'est celui dont la voyelle de liaison est différente de la voyelle de la syllabe qui suit:

fuscolimbatus	doit être préféré à	*fuscilimbatus*
albolineatus	” ” ” ”	*albilineatus*
rubricoloratus	” ” ” ”	*rubrocoloratus.*

LE FARDEAU DES VIEILLES ESPECES INCONNUES

par
Ch. FERRIÈRE,
Genève, Suisse

Les systématiciens connaissent sans doute tous, dans le groupe d'insectes qu'ils étudient, un certain nombre d'espèces décrites par des auteurs anciens et qu'il est impossible de reconnaitre d'après les seules descriptions. C'est sans doute surtout le cas pour les familles peu étudiées, qui n'ont intéressé que quelques spécialistes, qui n'avaient ni le temps ni les moyens d'aller étudier les vieux types disséminés dans plusieurs pays. Une de ces familles ou superfamilles, très grande et importante mais très négligée, surtout en Europe, est celle des Chalcidoidea, Hyménoptères parasites. Travaillant depuis plusieurs années à une monographie des 15 familles de Chalcidoidea paléarctiques, je me heurte continuellement à l'obstacle des vieilles espèces que personne ne connait et qui n'ont jamais été même mentionnées depuis leur première description.

Un court historique de l'étude de ces petits Hyménoptères fera mieux comprendre la situation. Les premiers entomologistes n'étudient quelques Chalcidiens qu'occasionnellement, avec d'autres insectes et seuls SPINOLA en Italie (1808-1811) et DALMAN en Suède (1818-1825) s'y intéressent plus spécialement. Jusqu'en 1832, environ 200 espèces sont décrites et ces premières espèces mentionnées par d'autres auteurs sont en général bien connues. Pendant les 20 années qui suivent, de 1832 à 1852, un intérêt très vif semble s'éveiller pour ces Chalcidiens ou Pteromalides comme on les appelait. Nous trouvons en Angleterre WESTWOOD, HALIDAY et surtout WALKER, qui décrivit près de 1500 espèces, en Hollande NEES AB ESENBECK, qui publie en 1834 sa „Monographia Pteromalinorum Europaeorum", en Suède BOHEMAN et ZETTERSTEDT, en France FONSCOLOMBE et BOUCHÉ, enfin en Allemagne FÖRSTER avec ses „Hymenopterologische Studien" et ses „Beiträge zur Monographie der Pteromaliden", puis RATZEBURG avec de nombreuses espèces nouvelles dans ses „Ichneumonen der Forstinsekten".

Pendant cette période de 20 ans près de 3000 espèces sont ainsi nommées et décrites en Europe. Que reste-t-il de tout celà? Pour la moitié environ de ces espèces, rien que des noms, dont il est impossible actuellement de tenir compte. Sur les 1500 espèces décrites par WALKER, à peine un tiers a été reconnu, des espèces de NEES une centaine devraient être réétudiées, les espèces de BOHEMAN sont connues grâce aux travaux de THOMSON sur les „Hymenoptera Scandinaviae", par contre une trentaine d'espèces de ZETTERSTEDT de Laponie sont encore inconnues, enfin plus de la moitié des espèces décrites par FÖRSTER n'ont été reconnues par aucun auteur, bien que MAYR ait pu en étudier plusieures. Que faire de ces quelques 1500

espèces, décrites il y a 100 ans ou plus, qui encombrent les catalogues, et que l'on ne sait même pas souvent où placer. Dans le „Genera Insectorum", SCHMIEDEKNECHT en 1909 a donné des listes des espèces dans les genres où elles ont été décrites. Par exemple dans le seul genre *Pteromalus* il donne une liste de 873 espèces, dont 748 ont été décrites avant 1852. Dans son sens actuel, le genre *Pteromalus* ne comprend qu'une dixaine d'espèces, les autres espèces ont été placées dans d'autres genres, grâce aux travaux de THOMSON, de MAYR et de KURDJUMOV, mais une grande partie des 350 espèces de *Pteromalus* de WALKER, des 237 espèces de FÖRSTER et de la centaine d'espèces de RATZEBURG sont restées inconnues et ne peuvent être placées nulle part.

La première chose à faire pour toutes ces vieilles espèces serait évidemment de rechercher et d'étudier les types. Ceux de WALKER sont pour la plupart au British Museum; mais le fait que pendant plus de 100 ans personne ne les a étudié montre qu'ils ne sont pas d'étude facile. Nous en avons examinés plusieurs, sur lesquels nous avons pris des notes, mais la plupart des espèces devraient être entièrement redéterminées et redécrites car WALKER, d'une activité intense, n'était pas toujours très exact dans ses déterminations et ses descriptions. Il y aurait là un travail considérable pour un bon spécialiste, dont la vie entière suffirait à peine! On peut dire la même chose des types de NEES, qui se trouvent à l'Institut zoologique de l'Université de Bonn et qui n'ont été réexaminés par personne; nous les avons vus serrés dans une boite et il faudrait repréparer la plupart des individus pour en faire une étude consciencieuse. Plusieurs des types de FÖRSTER sont au Musée de Vienne, où malgré les études de MAYR et de RUSCHKA, ils sont en grande partie encore inconnus. Quant aux types de RATZEBURG qui se trouvaient à Eberswald, ils ont été entièrement détruits pendant la guerre; mais, parasites d'insectes forestiers, leurs hôtes sont connus, de sorte qu'un entomologiste forestier en Allemagne pourrait faire des élevages et créer des néotypes.

L'étude des Chalcidoidea a été bâtie sur des bases plus solides en Europe, grâce aux recherches de spécialistes récents dans plusieurs pays; mais par la force des choses, un trop grand nombre d'espèces anciennes ne peuvent pas être prises en considération, parcequ'impossible à reconnaitre. C'est pour surmonter ces difficultés que nous voudrions faire les propositions suivantes:

1. Toute espèce qui a été décrite il y a plus de cent ans, n'a jamais été retrouvée depuis lors et ne peut être reconnue d'après sa description, ne doit plus être prise en considération.

2. Si le type est perdu, cette espèce doit être rayée des catalogues et traitée comme si elle n'existait pas.

3. Si le type existe encore, il ne pourra être rendu valide qu'après avoir été redécrit dans le genre auquel il appartient vraiment. Le nom du premier auteur est alors mis entre parenthèse et le nom de l'auteur qui a fait la nouvelle description est indiqué à la suite.

4. Dans le cas de la redescription d'une espèce restée inconnue et vieille de plus de cent ans, la question de la priorité en cas de synonymie est à discuter, ceci pour éviter que des noms bien connus soient remplacés par d'autres que personne ne connaissait.

DISCUSSION

Mr. **Bonnet**: Dans le cas où une espèce ancienne viendrait à être reconnue, et que son nom remplacerait un nom plus récent mais très employé, il faut demander à la Commission de Nomenclature de suspendre dans ce cas là la loi de priorité, pour que le nom utilisé soit maintenu contre le nom jusqu'ici inconnu.

Mr. **Ferrière**: C'est en effet ce qui se fait actuellement, mais il faudrait dans ces cas que les décisions de la Commission de Nomenclature puissent être prises plus rapidement, pour éviter des incertitudes parfois trop prolongées!

MEIGEN, 1800: A PROPOSAL FOR STABILITY AND UNIFORMITY

by

Curtis W. SABROSKY
Washington, U.S.A.

The conflict in the Diptera between advocates of the generic names of IEIGEN (1800) and those of MEIGEN (1803) is a long-standing controversy hat has divided the dipterists of the world for over forty years. It is unecessary to review the extensive literature of this well-known dispute, hich has been admirably summarized in an annotated bibliography by SMART 1944, Ann. Mag. Nat. Hist., ser. 11, 11: 261-272). It may be remarked, howver, that MEIGEN's 1800 paper was not actually "lost" for a century, for it as known to several leading entomologists and was cited at least twelve mes between 1802 and 1907. The controversy dates from its so-called redisovery by HENDEL (1908) and his application of the Law of Priority.

The problem was twice submitted to the International Commission on oological Nomenclature, and both times it was decided that the 1800 names ere published and available (Opinions 28, 152). Opinion 28 was issued omptly, in October 1910, and no charge of delay can be laid to the Commiion.

The problem could have been solved long ago in either of two ways:

(1) Suppression of the 1800 paper as soon as the Commission received the ower to suspend the Rules (1913). Such action would unquestionably have en been widely supported and would have avoided these four decades of iction and conflicting usage. It is indeed regrettable that no one promptly plied.

(2) Acceptance of Opinion 28, and prompt determination of the correct use the names. If dipterists had followed the Rules and Opinions and accept- l the names, as did HENDEL, KERTESZ, COQUILLETT, and others, we ould now have had forty years of usage based on the 1800 names, and the esent generation would have known the problem only as a historical curios- .

The period from 1908 to the present marks virtually the entire active reers of many leading dipterists who used the 1803 names exclusively, or most so – such authors as MALLOCH, CURRAN, ALDRICH, ALEXANDER, LANDER, HULL, JOHANNSEN, EDWARDS, COLLIN, AUSTEN, MACFIE, AINWRIGHT, VILLENEUVE, ENDERLEIN, THIENEMANN, GOETGHE- JER, FREY, RINGDAHL, G.H.HARDY, BRUNETTI, DE MEILLON, and ers. This group includes a number of the most prolific writers ever to blish on the Diptera. In the same period, there have been distinguished thors who used the 1800 names for at least a large part of the time, such HENDEL, FELT, HENNIG, LINDNER, KRÖBER, SPEISER, LENGERS- RF, and others, but the total of their contributions, though considerable

and important, will fall far short of matching the great bulk of literature produced by the former group. As late as 1932, F.W. EDWARDS' questionnaire showed that only 11 dipterists (13 per cent) of 85 replying were in favor of accepting the 1800 names.

What is the modern usage of the names? To answer this question, a survey was made of all available publications which involved the disputed 1800 names or their 1803 counterparts (Table 1). Particular attention was given to those published within the last twenty years, except for important reference works that have had no successors.

Table 1. Summary of Usage in Major Publications

	1800 Usage	Mixed Usage	1803 Usage
Diptera			
Catalogues	-	2	7
Manuals, etc.	8	4	32
Faunal Lists	1	3	21
General Entomology			
Textbooks	4	-	69
Zoological Record	-	-	1
Guides and Handbooks	2	-	18
Miscellaneous	3	3	36
General Zoology	-	-	31
Totals (245)	18	12	215
Percentage of Usage	7.3	4.9	87.8

It is clear from this survey that the major publications, both in Diptera and in general fields, show overwhelmingly predominant usage of the 1803 names. A great many of these works will be important references for years to come. In addition, general sources of information, such as the "Encyclopedia Britannica" (1950 ed.) and WEBSTER's "New International Dictionary" (1950), also use the 1803 names.

An interesting and significant point revealed by the survey is the lack of citation of the opposite usage of disputed MEIGEN names. Of the 245 major publications, only 29 consistently list the opposite usage. Sixteen of these are in Diptera, thirteen in general entomology, and none in general zoology. Of the 73 textbooks of entomology, only six (two in English, four in German) make it possible for a student to find the meaning of family names based on the opposite usage. Inasmuch as 88 per cent of the major publications use the 1803 names, their usage is further emphasized by the complete lack of mention of the 1800 names.

Recent usage

As a sample of recent usage, a survey was made of publications on Diptera listed in the last large pre-war volume of "Zoological Record" (1939).

in the last two volumes of the Record (1947, 1948), and in the last volume (1950) of the "Bibliography of Agriculture" (Library, U.S.Dept. of Agriculture). Table 2 presents a summary of those which involved the disputed genera *).

Table 2. Summary of Recent Usage

	Type of Publication						Authors		Countries represented	
	Taxonomic		Non-taxonomic		Totals					
	Number of papers	Per cent using 1803	Number of papers	Per cent using 1803	Number of papers	Per cent using 1803	Number	Per cent using 1803	1800 usage	1803 usage
Zool. Record										
1939	107	71	59	98	166	81	111	83	9	24
1947	83	76	22	95	105	80	78	77	10	24
1948	72	68	32	97	104	76	79	75	10	22
Bibliog. Agr.										
1950	66	70	36	86	102	75	82	74	6	16

These figures show that approximately 75 to 80 per cent of recent publications and of recent authors still used the 1803 names, three and four decades after the 1800 paper was revived. Of the taxonomic papers, approximately 70 per cent used the 1803 names; of the non-taxonomic papers, generally over 90 per cent (95 per cent of the four-year total of 149 papers). In all, 34 different countries were represented by authors using 1803 names, compared with 19 countries by authors using 1800 names.

As a further sample of usage, a survey was made of two great journals of economic entomology the "Bulletin of Entomological Research" (England) and the "Journal of Economic Entomology" (United States). Nine-tenths or more of the papers that involved any disputed MEIGEN genera used the 1803 names, as follows:

Table 3

	1911-1930		1931-1950	
	Number of papers	Per cent using 1803	Number of papers	Per cent using 1803
Bul. Ent. Res.	75	95	34	97
Jour. Econ. Ent.	73	89	51	90

*) Certain decisions were made for the tabulation: (1) The few papers with mixed usage were not counted; (2) joint authorship papers were credited to one author, the senior; (3) papers using Chloropidae were not counted as 1803 usage, because *Titania* 1800 has always been rejected by specialists in that family as a *genus dubium* incorrectly associated with *Chlorops*; (4) because authors are divided on whether *Trypeta* 1803 and *Euribia* 1800 are synonyms, papers using the name Trypetidae were not counted as 1803 usage unless the author specifically mentioned that he did not accept *Euribia*. On each point except the first, the opposite decision would have increased the percentage of 1803 usage shown in the table. In each volume, only the publications of that year and the one immediately preceding were counted.

As a small point of interest, after seeing the current books exhibited at this International Congress by several booksellers, I checked the usage in those books that involved MEIGEN names. Forty books used the 1803 names and nine the 1800 names. It is noteworthy that with few exceptions these books are the most up-to-date works, published between 1949 and 1951.

Discussion

Regardless of the history of the case, and the merits of past arguments, the vital questions today are those of stability and uniformity. How long will dipterists continue to contribute to confusion throughout entomology and zoology with two sets of names for so many families and important genera? If we are really interested in stability and uniformity, we should settle the MEIGEN names as soon as possible and make a definite contribution toward attaining those goals.

There is considerable usage on both sides, but the survey shows that predominant usage in specialized literature and overwhelming usage in general entomology and zoology are based on MEIGEN 1803 names. This is especially true for textbooks, so the next generation of entomologists is also being trained in the 1803 names. Further, the lack of cross references in those works means that students and general workers will have difficulty in finding the meaning of 1800 names when they encounter them.

The point may be raised that if all specialists now turned to the 1800 names – if we may imagine such a change – would not the general usage change accordingly? Perhaps it would, eventually, but how long would it take? How many years to change even the general entomology texts? And how many more to change the general zoologies? And how many, many more for the change to be felt in all the ramifications of zoology, in zoogeography, cytology, ecology, etc., and in dictionaries and encyclopedias, where now the 1803 names are used almost exclusively?

A splendid example of the difficulty is available. In the gall midges (Cecidomyiidae or Itonididae), the distinguished American specialist and virtually the only American worker on the family until recent years was E.P.FELT. Dr. FELT early (1911) adopted the 1800 name *Itonida* and used Itonididae (or Itonidae) for the family. In spite of the fact, however, that practically all American taxonomic literature in the family since 1911 has been under the name Itonididae, and that Dr. FELT was widely known and respected both as dipterist and economic entomologist, that family name has not been adopted in any American textbook of entomology *) and in only a single American faunal list (BRITTON, 1938).

It may also be noted here that while a number of taxonomists changed from 1803 to 1800 usage, there are and have been some prominent authors who adopted 1800 names for a time and then returned to 1803 usage. C.H.T. TOWNSEND used 1803 names until about 1910 or 1911, and then 1800 names for about twenty years, but he changed back to the 1803 names early in the

*) FERNALD and SHEPARD (1942) might be counted as adopting it, but they seem non-committal, "Itonididae or Cecidomyiidae".

1930's, so that his monumental "Manual of Myiology" (12 parts, 1934-1942) employed the 1803 names. The distinguished specialist on Chironomidae, J.J.KIEFFER, used the 1800 names in a number of papers from about 1911 to 1917, and then changed back to 1803 names for his remaining ten to twelve years of publishing. BEZZI followed 1800 usage until about 1920, but returned to 1803 names for his last eight years. An example among contemporaneous authors is E.SEGUY of Paris, who used the 1800 names for some years but who has returned to the 1803 names in his recent major works, "La Biologie de Dipteres" (1950), the section on Diptera in GRASSE's "Traite de Zoologie (tome 10, 1951) and in several other recent publications.

Assuming that uniformity is possible, how long will it take to achieve it by rule? How long to change the predominant 1803 usage to agree with the minority 1800 usage? Would it not be quicker and easier for the minority to change to the majority view? Specialists in Diptera, who are the main users of the 1800 names, are necessarily acquainted with both 1800 and 1803 names and could make any change relatively easily. The general and applied entomologists and zoologists, on the other hand, generally know and recognize only one set of names, which is almost always the 1803 set because they were so taught, and because their current textbooks and references are for the most part based on those names.

All things considered, it seems hopeless to expect uniformity under the 1800 names for many years, perhaps not for centuries, perhaps never. Piecemeal one-by-one consideration of the disputed names, as now under way by the International Commission, will prolong the agony, and in the end may not gain uniformity, however good the intentions. Finally, then, although I have been using the 1800 names myself for some years, I have come to the belief that stability and uniformity could be more quickly achieved by adoption of the 1803 names and the family names based upon them.

This is a position at which I have arrived as a practical solution, regardless of theoretical considerations. Lest my position be misunderstood, I wish to make it clear that, following the International Code of Zoological Nomenclature, I believe that the 1800 names are valid and available and should have been used. In spite of the harsh things said in recent years about the Law of Priority, the fact remains that the real fault lies with the taxonomists themselves. No principle can be effective, whether it be called a Law of Priority, a Law of Prescription, or any other, unless action by taxonomists is reasonably prompt, completely cooperative, and virtually unanimous.

If we cannot – as we certainly have not thus far in MEIGEN 1800 – achieve stability and uniformity by rule or principle, let us try it by agreement, or, if we must be formal about it, by suspending a rule. Late as it is, I believe that the *complete elimination* of MEIGEN's 1800 paper would be a distinct step forward in straightening out the nomenclature of the order Diptera, and would be a real contribution to stability and uniformity.

I am therefore proposing that the publication by MEIGEN (1800) be suppressed.

DISCUSSION

Mr. **Dos Passos** (chairman of the meeting): How many names are involved in the controversy? Why was ruling re 1800 not accepted?

Mr. **van Emden**: I can answer the question of the President. It was Dr. F.W.EDWARDS who took up the full struggle against the "1800 names" in the conviction that it was against all common sense to revive after more than 100 years names published by the author with the proviso that by omitting the mention of species names the generic names should remain invalid so as not to prejudice his intended detailed publication (see preface to MEIGEN 1800).

Mr. **Smart**: The names were available and it had been left to Dipterists to decide their validity. The current vote at which the Commission worked would take a long time to get thus all the names.

Mr. **Richards**: The case of the ERLANGEN List in Hymenoptera is exactly comparable. It was first validated by an Opinion, but later suppressed by another one.

PROPOSALS CONCERNING THE NOMENCLATURE OF FAMILY NAMES AND OF NAMES OF ECONOMICALLY IMPORTANT INSECTS, TO BE SUBMITTED TO THE IXth INTERNATIONAL CONGRESS OF ENTOMOLOGY AT AMSTERDAM

by

K. W. DAMMERMAN †

Leiden, Netherlands*)

To restrict the ever continuing changes of names and to arrive at a greater stability in nomenclature, it is advisable to obtain as soon as possible a fixation, in the first place of family names of insects and of the names of the most important insects of economic interest (noxious as well as beneficial species).

In this fixation the names that were in general use at the time of the beginning of the "Zoological Record" (1864), and that generally were in use till the introduction of the International Rules (1905), as far as possible are to be stabilized. Moreover, it is altogether advisable to pay attention to the nomina conservanda proposed by APSTEIN (Sitzb.Ges.naturf.Fr. 5: 119, 1915) and by HANDLIRSCH (in: Schröder's Handb.d.Entomologie 3: 79, 1915). (See also DAMMERMAN, Tijdschr.v.Entomologie 92: 34, 1950).

To arrive at results within reasonable time, the following procedure is recommended:

During three years, to start with 1952, or as many more as will appear necessary, an attempt will be made for the fixation of at least 10 names of families belonging to each of the following groups of insects: Hymenoptera 10, Coleoptera 10, Lepidoptera 10, Diptera 10, Rhynchota 10, Orthoptera, Thysanoptera, Mallophaga and Pediculina together 10, other orders of insects 10;

Moreover, at least 10 names of economically important insects belonging to each of the 7 above mentioned groups, and for each of the 6 following geographical regions: Europe (or, as the case may be, the Palearctic region), Africa, Oriental region, Australia, North America, and South America.

Concerning the family names a beginning will be made with the names that about 1864 were in common use.

The present Congress is requested to appoint an international committee for stimulation and coordination of the work meant in clause I. This committee shall sollicit co-operators or organisations to accept this task. Individual investigators willing to cooperate may apply to the committee.

Co-operators shall observe the following rules:

a. If an economically important insect at the same time is the type of a genus of which a well-known family name is derived, the reviser of this

*) Communicated by H.Boschma, Leiden, Netherlands.

family name shall communicate directly or through the sub III 1 named committee to the person who is charged with the fixation of the name of the insect concerned, to arrive as soon as possible to a unanimous proposal.

b. The same procedure shall be followed if an insect in more than one of the sub II 1 mentioned geographic regions is of great economic importance.

IV. Every entomologist or zoologist who detects a new name that on the basis of priority would lead to a change of a well-known family name or of the name of an insect of economic importance, shall not introduce such a name, but immediately shall communicate with the committee referred to above. This committee shall send the proposal for further consideration to the co-operator concerned.

V. 1. Every year the names dealt with by the co-operators shall be published, if possible after having obtained concurrence of the majority of an existing national committee on nomenclature or of an existing national organisation of entomology.

2. It will be requested to obtain permission for publication of the proposals mentioned above in the English language in the Bulletin of Zoological Nomenclature.

Moreover by announcement in the above named Bulletin or in the original publication all other journals suitable for the purpose shall be requested at least to publish the proposed names, with a reference to the number of the Bulletin or to the other publication concerned.

3. One year after publication of the proposals, when the opportunity for discussion may be deemed sufficient, the committee mentioned sub III 1, shall take a decision concerning the proposed names. All names having obtained the concurrence of at least two thirds of the members of the committee shall be published at once, and zoologists will be requested to use in future these names, whilst the International Commission on Zoological Nomenclature will be requested to place these names as soon as possible on the Official List.

4. Names that have not obtained a majority of two thirds of the votes of the members of the committee, shall not immediately be rejected, but shall remain under suspension during one year. Then the committee again shall consider these names. These names shall be rejected only when the committee can recommend another name to be used as the valid name.

(It may be observed that Dr. DAMMERMAN already has begun to formulate proposals concerning the fixation of family names of Coleoptera.)

DISCUSSION

Mr. **J. Chester Bradley**: I certainly am in accord with what Dr. DAMMERMAN seeks to accomplish, but believe that we must have time to study the proposal as concerns the effectiveness of its methods. We do have an In-

ternational Commission on Zoological Nomenclature and it would seem desirable that actions of the proposed committee be channeled through that Commission if for no other reason than to prevent conflicting action on cases that arise.

Mr. **Comeau**: That the proposed committee shall be the channel to the International Commission on Zoological Nomenclature without taking the final decisions but the Int.Com. shall take in consideration the approval of the said committee.

Mr. **Sabrosky**: I have been interested in the problem of family names for many years, and presented a paper on the matter at Berlin in 1938. An application was also presented to the Commission in 1945, but this has not yet been published.

My efforts have been directed toward arriving at some uniformity of principles used in family names, but my private opinion is that as a practical solution we might as well try to reach agreement on a set of names for all families. I see no real practical reason why we must necessarily apply any given principle rigidly throughout all families. If one familiar family name has been selected on one basis, and another familiar name on another basis, I think that both could be used if we could find a way to reach agreement on their use.

Mr. **Boschma**: remarks that he has presented the paper at Dr. DAMMERMAN's request, but agrees that there ought not to be a committee on nomenclature separate from the International Commission.

Mr. **Bradley**: proposes the following motion: I move that Dr. DAMMERMAN's motion be referred to the International Commission on Zoological Nomenclature with expression of the sympathy of this meeting towards its objectives.

This motion is unanimously carried by the meeting.

Mr. **Kent H. Wilson**: Have the "neotype" specimens submitted with a photograph and description of same to the Commission on Zoological Nomenclature. The name, published as under consideration and left on the table until the next meeting, at which time, any opposition can be raised and studied by the commission. The commission could hand down a decision as to the validity of the "neotype".

A SERIES OF TAXONOMIC INACCURACIES, ANOMALIES, AND SOME MONSTROSITIES OF NOMENCLATURE IN THE FORMICIDAE

by
D. WRAGGE MORLEY
London, England

Summary

For a long time Formicid taxonomy has been neglected largely because one single person, the last living member of the Great Five students of ants (FOREL, WASMAN, WHEELER, EMERY, and DONISTHORPE) has been the only person capable of comprehending the whole of its complexities. Since one individual cannot conceivably follow all the arguments, and the naming of new species in any large group of insects throughout the world, this has led to considerable confusion of taxonomic treatment within the ants (Formicidae). An attempt is made here to outline the general structure of the subfamilies, sections and tribes, and to point out some of the anomalies that occur in the literature of any taxonomy as it exists at present, even down to the level of specific examples of species, sub-species, and the introduction of such taxonomic terms as races and sub-races.

While more of a critique than a creative examination, this paper does endeavour to clear up many of the confusions at present existing.

SECTION III

GENETICS AND ONTOGENY

CONTRIBUTION A L'ETUDE DU PHENOMENE DE LA DIAPAUSE EMBRYONNAIRE CHEZ UN ACRIDIEN, Locusta migratoria gallica REM. (phasis transiens)

par

J.R. LE BERRE

Versailles, France

Les phases de repos qui s'installent à un stade donné du cycle évolutif des insectes ont suscité des recherches plus ou moins précises, aux résultats plus ou moins catégoriques.

Selon G. COUSIN (1932 p.9) „... Pour être défini, chaque cas particulier de diapause demande, non seulement une observation dans la nature, mais une étude expérimentale qui permette de spécifier les causes externes ou physiologiques, ou les causes souvent complexes qui déterminent le phénomène...".

Afin d'effectuer une étude aussi precise que possible du phénomène de diapause qui caractérise la majorité des oeufs du Criquet migrateur des Landes, *Locusta migratoria* sb. sp. *gallica* REM. nous avons mis au point une série de techniques, les unes personnelles, les autres imitées de différents auteurs.

Nous exposerons successivement dans cette note, outre les méthodes utilisées, quelques-unes des premières conclusions générales qui peuvent être, dès maintenant, formulées.

Le matériel biologique récolté dans les Landes en août 1948 se composait de 80 femelles et 75 mâles que des mensurations, effectuées selon les repères indiqués par ZOLOTAREWSKY (1929), permettent de ranger dans la *phase transiens*.

L'évolution embryonnaire de la première génération obtenue au Laboratoire, et comprenant près de 10.000 oeufs, a montré une telle hétérogénéité, qu'un premier travail de sélection s'est avéré être absolument nécessaire, avant que toute étude sur la diapause embryonnaire de cet Acridien puisse être entreprise avec fruit (LE BERRE, 1951a). Nous rappellerons, très brièvement, les données essentielles de cette ségrégation de deux formes biologiquement distinctes.

Le diagramme Ia et Ib montre l'échelonnement des éclosions sans diapause vraie observées dans un groupe de 7840 oeufs soumis à une incubation à 33° C. d'une durée de 200 jours.

En résumé, cette première génération issue du materiel récolté dans la nature se caractérise par la présence de:

0,95% d'oeufs sans diapause (éclosions relevées entre les 14e et 26e jour d'incubation à 33° C.);

5,41% d'oeufs à diapause intermédiaire *)(éclosions remarquées entre les 37e et 156e jour);

93,64% d'oeufs à diapause vraie (Refrisc de développement nécessitant l'intervention d'un agent réactivant, de nature physique ou chimique).

Au cours de cette incubation prolongée, une courbe de mortalité a pu être dressée à l'aide de quatre lots d'oeufs comprenant respectivement: 200 oeufs, 160 oeufs, 250 oeufs et 90 oeufs. Les chiffres moyens suivants ont été obtenus:

8,75 % de mortalité après 60 jours d'incubation à 33° C.
23,5% de mortalité après 90 jours d'incubation à 33° C.
43,5 % de mortalité après 120 jours d'incubation à 33° C.
60,5 % de mortalité après 150 jours d'incubation à 33° C.
82,5 % de mortalité après 200 jours d'incubation à 33° C.

L'élevage pendant six générations successives des Criquets dont l'embryogénèse n'est pas caractérisée par la présence d'une diapause vraie, nous a conduit à une forme absolument sans diapause, c'est à dire que tous les oeufs de 6è génération déposés par une femelle se sont développés en 13 jours à 33° C. (Les graphiques II, III, IV tirés d'un travail antérieur (1951a), récapitulent l'évolution progressive des lignées vers la forme sans diapause).

Pareillement, une forme totalement à diapause a été sélectionnée à l'aide de la première génération éclose après action d'un agent réactivant (température 0° C.) convenablement appliqué.

Si la présence d'une diapause embryonnaire dans le cycle du Criquet migrateur ne semble pas être spécialement liée aux phénomènes de grégarisation, toujours susceptibles de se produire dans une population suffisamment abondante, la „ségrégation" des deux formes que nous avons effectuée, ne postule pas obligatoirement la valeur héréditaire de ce caractère biologique. Seuls, des croisements entre ces deux formes permettront de trancher cette question.

Par ailleurs, les modalités d'action des facteurs susceptibles d'agir sur la diapause embryonnaire du Criquet migrateur des Landes, en élevage depuis cinq générations au Laboratoire, ont fait l'objet de recherches qui ont été exposées ailleurs (LE BERRE, 1951 a et b). Nous avons emprunté à E.SLIFER l'élégante technique de „déchorionnage" des oeufs, qui, sans créer de perturbations apparentes dans l'organogénèse, permet de suivre in situ et in vivo le développement de l'embryon soit avant son entrée en quiescence, soit après sa réactivation. La nomenclature des stades morphologiques caractéristiques de l'évolution embryonnaire a été élaborée suivant les travaux de H.V.STEELE (1941) sur *Austriocetes cruciata* Sauss., puis suivant ceux, plus récents, de V.G.JHINGRAN (1947) sur *Schistocerca gre-*

*) Nous avons convenu de dire que des oeufs sont à diapause intermédiaire lorsqu'ils sont caractérisés par une phase de repos s'établissant au même stade embryologique que les oeufs à diapause vraie, mais qui s'élimine d'elle-même, sans le concours d'aucun agent réactivant, quel qu'il soit.

garia Forsk. et de R.W.SALT (1949) sur trois espèces de *Melanoplus*. Les figures que nous observons sont très semblables à celles décrites par STEELE et la période de repos s'installe au stade 10 (embryon enfin anatrepsis).

Les conclusions générales qui ont été formulées par BIRCH (1942) et par ANDREWARTHA (1943-1944) sur la diapause embryonnaire d'*Austroicetes cruciata* Sauss. sont applicables à notre matériel biologique.

1) L'action, même prolongée, du froid sur des oeufs âgés de quelques jours seulement, et en diapause, n'entraîne aucune reprise de développement.

2) L'embryogénèse est presque totalement inhibée aux températures élevées de l'ordre de 30° C. et 40° C.

3) Par contre, l'action prolongée des températures modérées, comprises entre 16° C. et 25° C. par exemple, permet a l'embryon d'atteindre un stade particulièrement favorable à l'action réactivante du froid. Encore est-il nécessaire que *cette action réactivante soit définie: dans son degré thermique, sa durée d'action, et son moment d'application.*

4) Il existe un stade évolutif sensible à l'action de l'agent réactivant. *Si ce stade n'est pas atteint, la diapause ne peut être éliminée. S'il se trouve dépassé, la diapause n'en sera que plus difficile à rompre.*

5) Enfin les conclusions conjugées d'ANDREWARTHA et de BIRCH, permettent de définir une certaine échelle thermique dans les limites de laquelle la diapause est facilement rompue.

Le développement embryonnaire des oeufs à diapause peut être divisé, à notre sens, en quatre périodes principales, qui, pour être arbitraires, n'en sont pas moins justifiables.

Période I - Va de la ponte de l'oeuf jusqu'à l'entrée en diapause de celui-ci.

Période II – intéresse toute la durée de la phase de repos.

Période III – correspond au temps d'action de l'agent réactivant.

Période IV – s'étend de la reprise de développement jusqu'à l'éclosion.

Seule, la dernière période a pu être définie avec suffisamment de précision. Selon la technique de réactivation des embryons en diapause utilisée, la reprise du développement peut être immédiate, et intéresser la totalité des oeufs, ou plus ou moins différée, et ne caractériser alors qu'un tout petit nombre des oeufs en expérience. Ces variations dans la réponse des embryons – une fois replacés dans les conditions de milieu favorables au développement – à l'action réactivante nous a conduit à n'admettre une *diapause comme parfaitement éliminée, que lorsque les éclosions ont lieu dans le plus bref délai et en grand nombre.*

Il apparaît alors que ces périodes minima obéissent, en première approximation, à la loi de VANT'HOFF et ARRHENIUS.

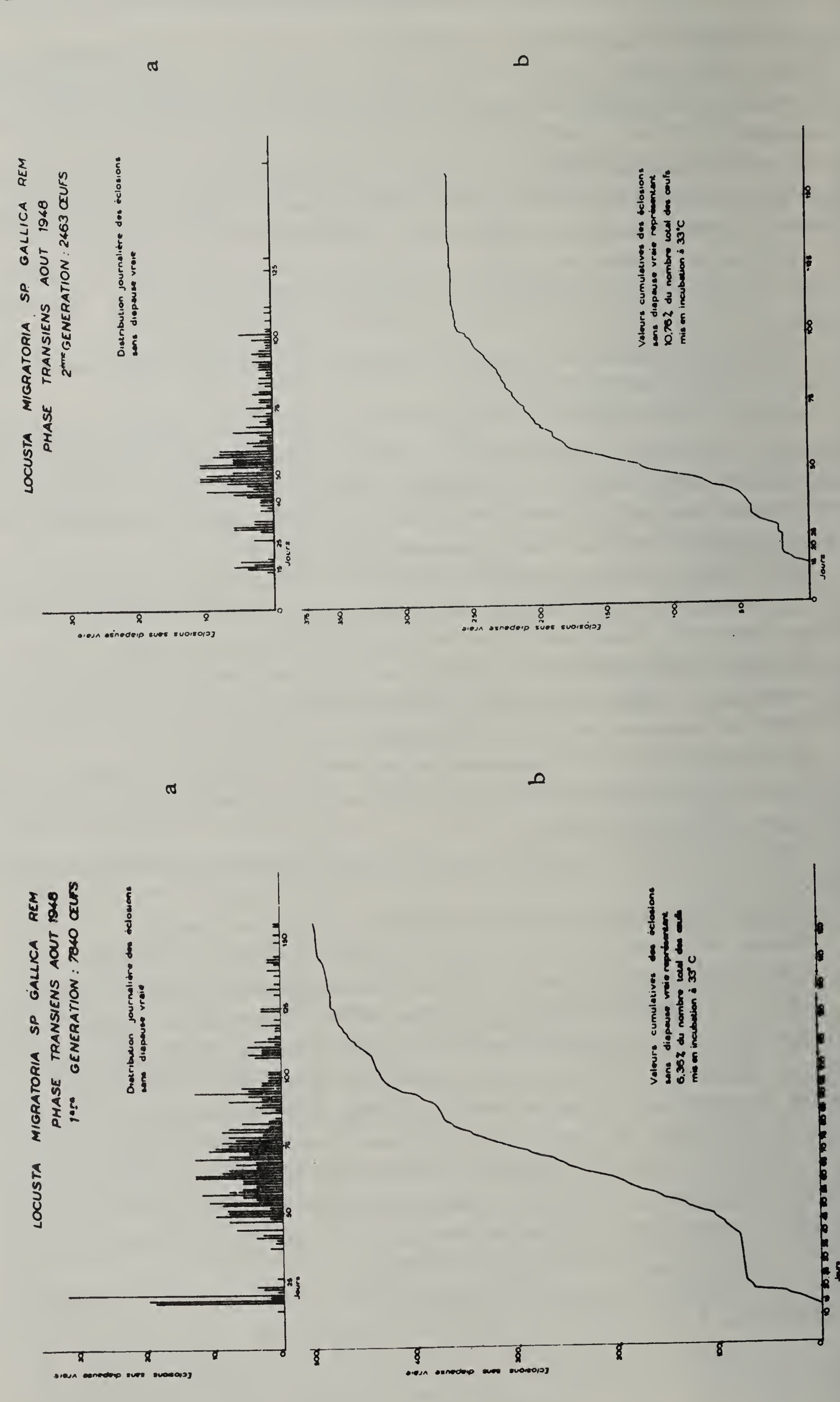
LOCUSTA MIGRATORIA SP GALLICA REM
PHASE TRANSIENS AOUT 1948
2ème GENERATION : 2463 ŒUFS
Distribution journalière des éclosions sans diapause vraie
Eclosions sans diapause vraie
Jours
a
Valeurs cumulatives des éclosions sans diapause vraie représentant 10,76% du nombre total des oeufs mis en incubation à 33°C
b
LOCUSTA MIGRATORIA SP GALLICA REM
PHASE TRANSIENS AOUT 1948
1ère GENERATION : 7840 ŒUFS
Distribution journalière des éclosions sans diapause vraie
a
Valeurs cumulatives des éclosions sans diapause vraie représentant 6,36% du nombre total des oeufs mis en incubation à 33°C
b

Fig. 2

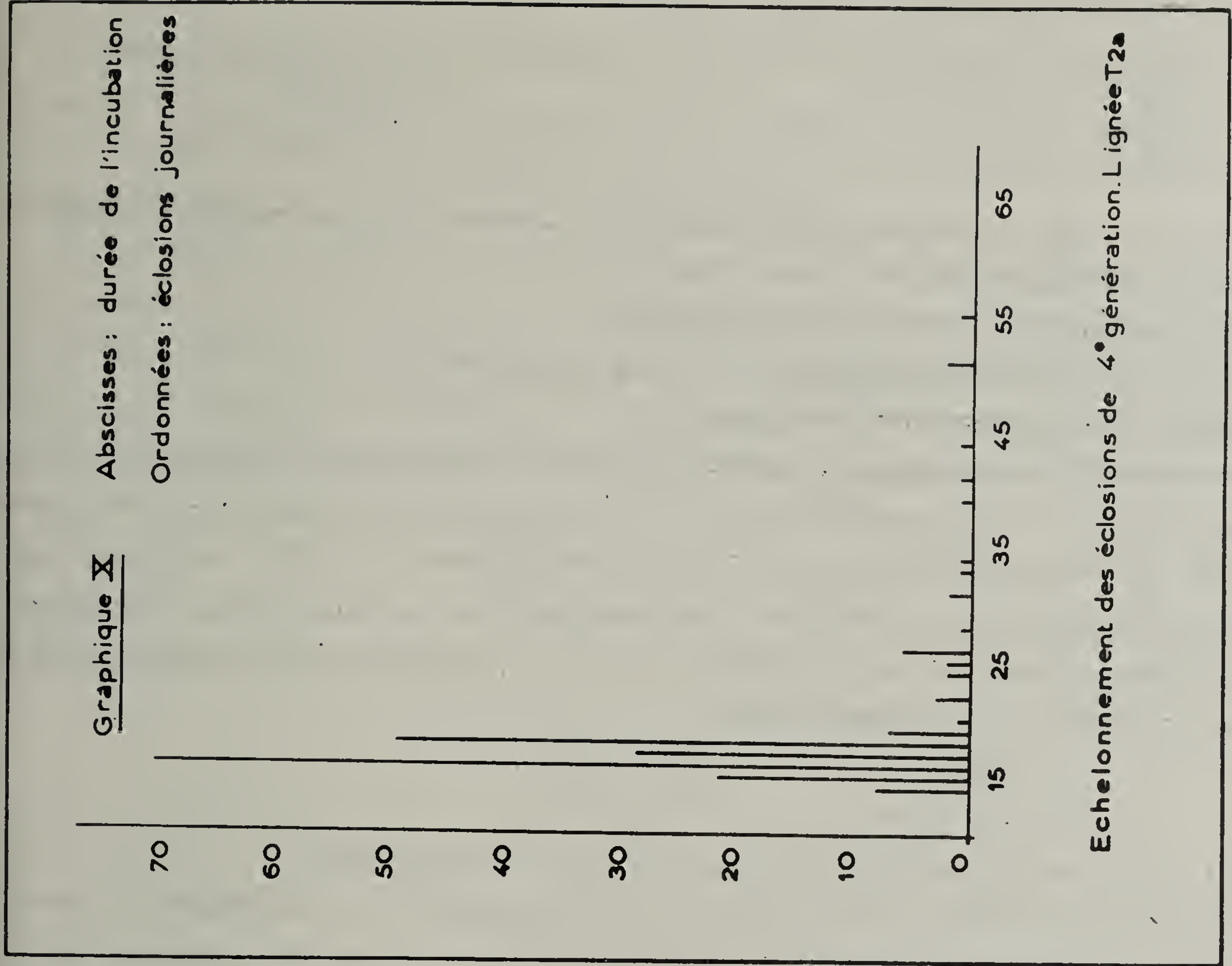

Fig. 4. Le pourcentage d'oeufs ayant éclos est de 54,92.

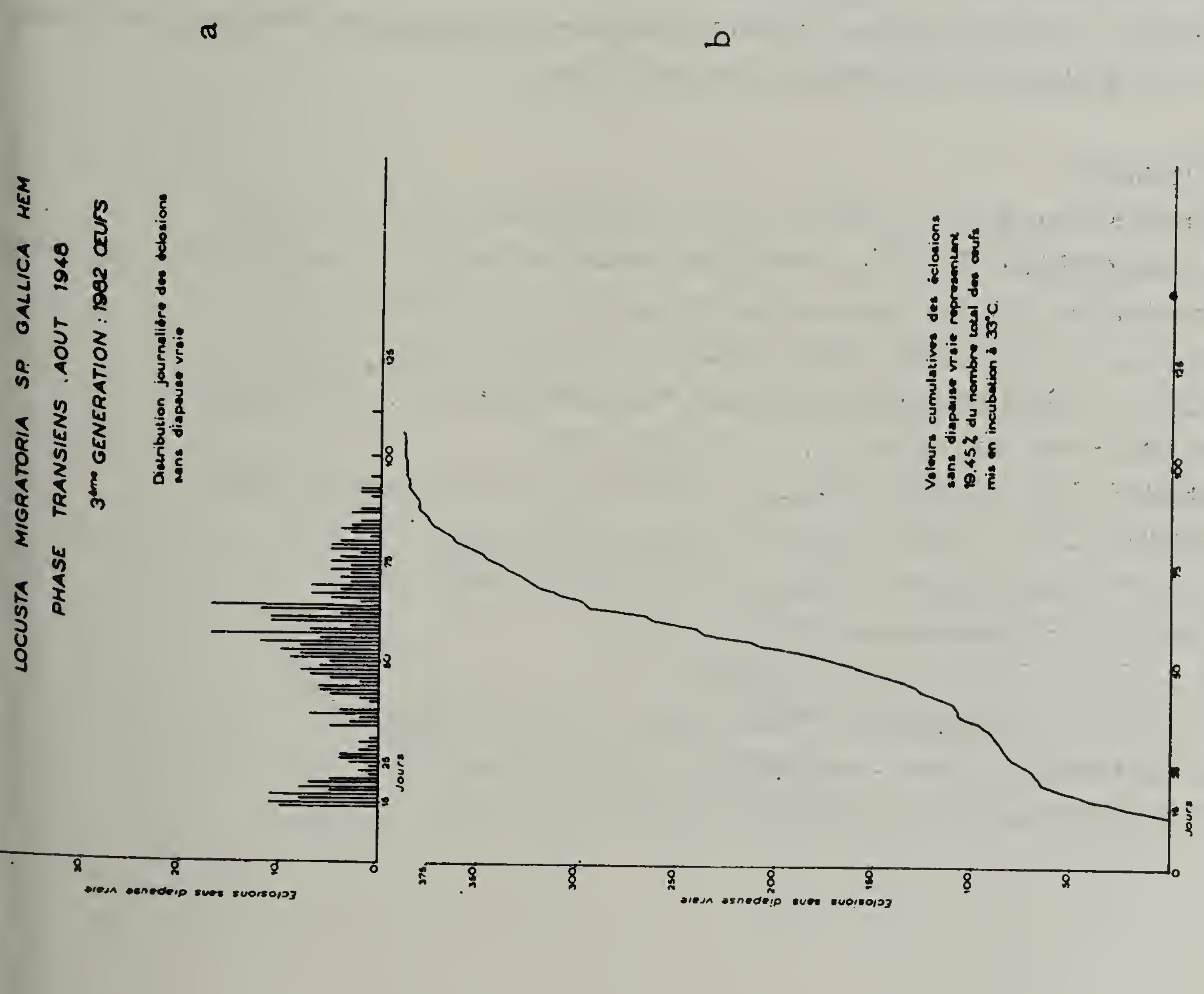

Fig. 3

Températures d'incubation utilisées après réactivation	Durée du développement embryonnaire après la rupture de la diapause
33° C	10 jours
25° C	18 jours
21° C	40 jours

– (Dans le cas où la période des éclosions s'étend sur plusieurs semaines, trois groupes de faits peuvent être invoqués:

1. Hétérogénéïte du matériel biologique;
2. Embryons n'ayant pas atteint la stade sensible;
3. Action réactivante insuffisante.) –

Ce principe étant admis, les oeufs de la forme à diapause doivent demeurer un certain temps τ à la température θ^o (θ^o supérieure au zéro de développement) pour qu'un séjour de durée τ' à la température θ'^o (θ'^o inférieure au zéro de développement) détermine une réactivation en masse des embryons. Ceux-ci, placés ensuite en incubation à 33° C, terminent leur organogénèse en 10 jours. Nous avons observé que

si τ = 60 jours, θ^o = 25° C.
τ' = 60 jours, θ^o = 8° C.

la réactivation intéresse 82,6% des oeufs mis en expérience.

Récemment cependant (LE BERRE 1951b), nous avons démontre l'importance de la température initiale d'incubation sur les oeufs pondus par la forme à diapause. Les études en cours doivent nous permettre de préciser, outre la valeur des trois premières périodes précédemment indiquées, les phénomènes physiologiques et biochimiques qu'engendre l'action des différentes températures expérimentales utilisées.

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DISCUSSION

M. **Bodenheimer** félicite M. LE BERRE de son exposé extrêmement intéressant. Mais la diapause ne se fait pas dans l'anatrepsis mais à sa fin, correspondant à la conception morphologique de diapause entre les deux phases actives de la blastokinèse de WHEELER.

Mr. **Le Berre**: Chez le Criquet migrateur, l'entrée en diapause se situe aux stades 9 à 10 de STEELE, avant début de segmentation des appendices. Le terme anatrepsis définit la position de l'embryon dans l'oeuf. Il est certain que la diapause s'installe en fin anatrepsis. Mais il est très difficile de donner avec précision le moment de l'entrée en diapause de l'embryon.

RÔLE DU CERVEAU AU COURS DE LA METAMORPHOSE DE CALLIPHORA ERYTHROCEPHALA MEIG.

par
Bernard POSSOMPÈS
Paris, France

Des conclusions souvent incertaines, parfois contradictoires, ont été formulées au sujet de l'action du cerveau sur le déclanchement de la métamorphose des Insectes. A la suite de KOPEĆ (1917, 1922), de nombreux auteurs, travaillant exclusivement sur des Lépidoptères, ont cherché à mettre en évidence une action cérébrale directe par des expériences d'ablation (KÜHN et PIEPHO, 1936; BOUNHIOL, 1938) ou d'ablation accompagnée d'implantation (CASPARI et PLAGGE, 1935; PLAGGE, 1938). Par contre, chez le Ver à soie, FUKUDA (1944) conteste la possibilité d'une action hormonale émanant du cerveau et induisant la pupaison.

Chez *Rhodnius prolixus* (Hemipt.), WIGGLESWORTH (1940) a déclanché la mue de façon incontestable sous l'action d'un greffon d'origine protocérébrale et a pu attribuer aux cellules neuro-glandulaires de la *pars intercerebralis* l'action hormonale ainsi mise en évidence.

Les recherches de WILLIAMS (1946, 1948) sur la diapause nymphale de *Platysamia cecropia* (Lépidoptère) conduisent à une conception moins simple du mécanisme d'action du cerveau. Ce dernier agirait, non directement, mais en stimulant le fonctionnement de la glande prothoracique ainsi conduite à sécréter l'hormone de croissance.

En ce qui concerne les Diptères, nous possédons peu de données. M.VOGT (1942), chez *Drosophila Hydei*, implante des cerveaux issus de larves prêtes à la pupaison dans des parties postérieures de larves isolées par ligature (posée avant la période critique) et conclut à une absence d'influence du cerveau sur les processus de métamorphose. DE LERMA (1942) relate très sommairement des expériences effectuées chez *Sarcophaga carnaria* et ses résultats suggèrent, au contraire, la possibilité d'une action cérébrale sur la formation du puparium tout au moins.

Nous connaissons avec certitude la source du facteur de métamorphose chez les Diptères Cyclorrhaphes. Le fonctionnement de l'anneau de WEISMANN, organe producteur de l'hormone de croissance, ne serait-il pas lui-même tributaire de stimulations d'origine cérébrale? J'ai tenté, par un ensemble d'expériences variées, de mettre en évidence une telle dépendance fonctionnelle et d'analyser le mécanisme d'action du cerveau larvaire chez *Calliphora erythrocephala* (POSSOMPÈS, 1948, 1949, 1950). Toutes les opérations ont porté sur des larves du dernier stade d'âges variés, mais toujours prélevées au-delà du terme de la période d'alimentation obligatoire; des animaux plus jeunes n'ont été éventuellement utilisés que comme donneurs de greffons.

1. *Expériences d'ablation totale et fractionnée du système nerveux:*

Au-delà d'une certaine période critique, l'anneau de WEISMANN est susceptible d'induire, à lui seul, la métamorphose. Avant cette période critique, il est inapte à agir de façon autonome; son activité, dans ce dernier cas, dépend étroitement de la présence du cerveau.

2. *Rupture des connexions nerveuses cerveau—anneau de WEISMANN:*

L'activité de l'anneau de WEISMANN exige l'intégrité des connexions nerveuses de cet organe avec le cerveau jusqu'à un âge critique de situation comparable à celle de l'âge critique signalé dans le paragraphe précédent. Dans les deux cas cette période critique précède dans le temps la période critique d'action de l'anneau de WEISMANN.

3. *Implantation de cerveaux et d'anneaux de WEISMANN:*

Des larves du troisième stade dont le jabot distendu par les aliments emmagasinés atteint son volume maximum, reçoivent un implantat de nature variable; ce dernier, dans ces conditions, poursuit son évolution, s'accroît et se développe. Les larves pourvues d'un tel greffon sont ensuite privées de leur propre anneau de WEISMANN à un âge où la métamorphose exige encore la présence de cet organe. L'évolution ultérieure de ces animaux est évidemment fonction de l'activité de l'implantat.

Tous les implantats utilisés ont été prélevés sur des larves de divers âges des premier et deuxième stade ou sur des larves très jeunes du troisième stade.

Dans ces conditions, un anneau de WEISMANN, ou un cerveau, ou un anneau de WEISMANN et un cerveau privés au préalable de leurs liaisons nerveuses, se révèlent inactifs et l'hôte demeure à l'état larvaire.

Par contre, un implantat constitué par un cerveau et un anneau de WEISMANN associés par leurs connexions nerveuses normales se montre actif, déclanche la formation du puparium, la mue nymphale et, abondamment pourvu de trachées au cours du remaniement nymphal, demeure physiologiquement actif et exerce une action durable menant l'hôte jusqu'au terme de la morphogénèse imaginale.

Un résultat identique est obtenu sous l'action d'un greffon comportant un anneau de WEISMANN associé à la seule fraction protocérébrale du cerveau.

Dans ces derniers cas où un anneau de WEISMANN, incapable au départ d'induire à lui seul la métamorphose, s'est montré actif du fait de sa liaison avec la totalité ou partie du cerveau, on observe une croissance normale des grandes cellules glandulaires (glande péritrachéenne) et celles-ci parviennent à la taille que, demeurées en place, elles auraient atteinte au terme de la vie larvaire du donneur.

Des résultats exposés ci-dessus, il peut être conclu qu'un stimulus initial né dans le cerveau, probablement au niveau des cellules neuro-sécrétrices du *protocerebrum*, active l'anneau de WEISMANN et plus spécialement les grandes cellules glandulaires composant la majeure partie de cet organe. Ces cellules, à leur tour, sécrètent un facteur induisant la metamorphose et

conduisant celle-ci jusqu'à la réalisation de l'imago. L'intégrité des connexions nerveuses exigée par l'action cérébrale sur la glande en anneau permet de supposer une intervention possible d'éléments du *corpus cardiacum.*

Ces données s'apparentent aux résultats obtenus par WILLIAMS dans son étude de la diapause nymphale de *Platysamia cecropia* et probablement aussi aux conclusions des expériences de WIGGLESWORTH sur la mue de *Rhodnius prolixus*; chez ce dernier insecte, en effet, on peut supposer l'intervention d'une glande de situation post-céphalique, non entraînée par la décapitation et qui, activée par la sécrétion des cellules neuro-glandulaires du *protocerebrum,* libérerait l'hormone de mue.

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(Sont seuls relevés ci-dessous les travaux expérimentaux. Les travaux purement histologiques et cytologiques sur la neuro-sécrétion chez les Insectes n'ont pas été cités.)

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DISCUSSION

Mr. **Burtt**: THOMSEN a démonstré quelques cellules dans le pronotum de l'imago de *Calliphora* qui régulent le développement des ovaires. Est-ce-que celles-ci sont identiques avec les cellules, qui régulent la nymphose?

Mr. **Possompès**: Les cellules neuro-sécrétrices du protocerebrum de l'imago et celles du cerveau de la larve sont les mêmes éléments.

Mr. **Maher Ali**: Est-ce-que le cerveau est implanté avec ou sans le ganglion frontal et le ganglion sous-oesophagien?

Mr. **Possompès**: Les implantats utilisés ne comportent ni le ganglion frontal, ni la masse sous-oesophagienne.

THE DEVELOPMENT IN VIVO OF TIME-FIXED EGGS OF COCHLIDION LIMACODES HUFN. (Fam. Cochlididae, Lepidoptera)

by

P. HOLST CHRISTENSEN

Copenhagen, Denmark

The fact that the development of the eggs of butterflies must be said to have received a somewhat unfriendly treatment within insect embryology is no doubt in great part due to the very considerable technical difficulties besetting such studies. For by far the majority of the eggs of the Macrolepidoptera are inclosed in an, as a rule thick, porcelain-like, and intransparent shell (the chorion) which renders impossible any direct observation of the living contents inside. If, therefore, the eggs are to be subjected to a histologic-embryological investigation the shells must be removed prior to sectioning – a most difficult process, which it is understandable that many investigators have avoided. To this must be added that the eggs, owing to the copious yolk, are among the most difficult to section, further, the form of the egg if often unfavourable to exact orientation in paraffin, especially in the case of globular eggs.

In contrast with the often fairly good-sized eggs of the Macrolepidoptera, those of the Microlepidoptera present certain unquestionable advantages for embryological studies: (1) The eggs are as a rule small, which reduces the expenses of the investigation (slides and cover-slips); (2) the moths are easily bred in cultures; (3) the eggs are often transparent; and (4) they are sometimes flat, which must be a great advantage in direct observation under the microscope. And as a matter of fact, several valuable investigations on the embryology of butterflies have been made – more especially recently – precisely on Microlepidoptera, e.g. HUIE's work (1918) on *Eudemis naevana* (Hb.), that of SEHL (1931) on *Ephestia Kuehniella* Zell., and MÜLLER's study (1940) of *Plodia interpunctella* Hubn. The ideal subject of investigation in the study of butterfly embryology must, therefore, according to the above, be a *flattened, thin-shelled, transparent butterfly egg, preferably not very large.* Where shall we be able to find such an egg? The fact that conditions are so favourable within the Microlepidoptera group will, I think, warrant the inference that we might with some probability expect to find something among the Macrolepidoptera placed lowest in the system, i.e. among the transitional forms between the Micro- and Macrolepidoptera. On a closer analysis this hypothesis has indeed proved correct. The moth *Cochlidion limacodes* Hufn., rare in Denmark and occurring mainly in the southern parts of the country, has eggs of the desired type. I have indeed already discussed this question in two previous publications (HOLST CHRISTENSEN 1943 and 1950), where the embryology of this form was partly treated. Since

then, I have moreover in the latter paper thoroughly described the anatomy of the *limacodes* egg. Here I shall only mention what may be considered of importance for the exposition to follow. The egg of *Cochlidion limacodes* is as a rule flat, scale-like and oval, and measures about 0.90 mm in length and about 0.65 mm in breadth. Outermost it is surrounded by a thin, transparent egg shell, which is provided with a characteristic sculpturing reminiscent of the meshes of wire netting. At one end of the egg is observed the micropyle apparatus, consisting of two concentric circles of wedge-shaped "leaves", the inner ones of which delimit a centrally placed area with about 6-8 micropyle canals intended for the passage of the sperms. The fertilized ♀♀ were confined in cages specially constructed for the purpose of slides and cellophane paper, on which they very readily laid their eggs, particularly in the night. Inside the egg shell comes the vitelline membrane (*membrana vitellina*), and inside this again a mixture of so-called formative yolk (*cytoplasm*) and nutritional yolk (*deutoplasm*). The cytoplasm is especially found as an extremely thin peripheral layer (*periplasm*), just under the vitelline membrane and besides through the whole mass of the egg as an exceedingly fine sponge. The glass or cellophane plates were then placed directly under the microscope by the aid of which they could be studied and photomicrographed (Edinger's projection apparatus was used). Better photomicrographs, however, could be obtained by placing the living eggs in destilled water with a cover-slip over supported by two pieces of cut-off brass pins about 1 mm thick and almost the same width as the cover-slip. For the most part Perutz's "Silbereosin-Platten" were used in combination with a green filter. When the eggs were kept suitably moist, they developed quite normally on this foreign substratum, in the course of 8-10 days, according to the temperature.

At about 20° C the egg will on its first day contain *vitellophags* and numerous *cleavage nuclei* giving rise to the formation of the *blastoderm* stage. At a somewhat higher developmental temperature (about 24° C) this stage is reached 11¼ hours after oviposition. If we examine the same egg about 14 hours after it has been deposited, the ventral plate has been formed, presenting itself as a broad, slightly curved band with rounded incurved ends, which are placed on the dorsal surface of the egg. About 17 hours after oviposition, the embryonic rudiment is very plainly present, it has now shortened considerably, the form being tongue-shaped. The deutoplasm has become more or less divided into large territories – the so-called secondary cleavage of the yolk mass. The two embryonic envelopes: the *amnion* and the *serosa* have also been formed. 36¼ hours after oviposition, or when the egg is about 2 days old, we notice that the germ band has been transformed into a worm-like embryo coiled in a close spiral. The fatty droplets in the territories have increased in size and the embryo has a plainly visible head- and tail-part, the former with well developed head lobes. 63¼ hours after the egg has been laid, or when it is about 3 days old, the embryo is percept-

ibly thicker, spiral-shaped and with large head lobes; furthermore a "tail-plate" is very well developed and a distinct segmentation is present too. 83¼ hours after oviposition, or when the egg is about 4 days old, the appearance had totally changed, the embryo being maggot-like, incurved and with 2 distinct caudal "humps". The segmentation is plainly present in many places, but the "tail-plate" has disappeared. 107¼ hours after the egg has been laid, or when it is about 5 days old, the embryo is now bent together side to side and more caterpillar-like. A second *blastokinesis* *) has been completed, the head now being turned towards the micropyle. Eyes, an oesophagus, mid-intestine and rectum are plainly visible. 131¼ hours after the egg has been laid, or when about 6 days old, the embryo has grown considerably and taken up a good deal of space in the egg. 155¼ hours after oviposition or when the egg is about 7 days old, the larva is almost fully developed, filling the greater part of the space within the egg shell; the yolk mass is chiefly present in the region in front of the animal's head, and in addition the mandibles, the eyes, the head capsule and the mid-intestine, the tracheae are now also plainly visible. 179¼ hours after the egg has been deposited, or when it is about 8 days old, the amnion and the serosa have disappeared, and the yolk mass has been entirely consumed. The caterpillar is very restless and ready to emerge at any moment. By means of the mandibles it pierces the chorion and with violent convulsive movements gradually works its way out of the egg shell. In this specific case hatching took place 180¼ hours after oviposition.

The main purpose of the present investigation has been to show that it is possible to supply an accurate description of the progressive development of exactly dated *living* moth eggs at known temperatures, and under developmental conditions as nearly as possible like the natural conditions. I am of opinion that such in vivo-studies of the eggs of both Macro- and Microlepidoptera may in future shed new light on problems as yet unsolved in insect embryology.

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*) At the first *blastokinesis* the embryo was turning on its side.

DISCUSSION

Mr. **Le Berre**: Parallèlement à cette étude de l'embryogénèse in vivo et in situ, la morphologie des differents stades a-t-elle été précisée? Il est en effet possible d'éjecter l'embryon de l'oeuf, même a des stades relativement précoces.

Mr. **Holst Christensen**: As pointed out in my lecture, it has been the main purpose of this investigation to study the development of intact, living *limacodes*-eggs, e.g. *in vivo* and *in situ*. The morphology of the different stages has been studied accurately as far as the transparent egg shell allows, but on account of lack of abundant material (the moth is rare in Denmark) I have not been able to study the embryo *in vitro* too, e.g. when taken out of the egg. This is quite another investigation which should be very interesting, especially when compared with sections through eggs of exactly known age.

Mr. **Maher Ali**: Can you tell me roughly when you would start to see the tracheal system? Some larval material of mine shows that there is a possibility of the secretion of a hormone connected with the tracheal system.

Mr. **Holst Christensen**: It is a rather difficult question to answer quite correctly, because the moment when the tracheal system is visible depends for a great part on the temperature. In the case of this egg which developed at 24° C, I suppose the tracheae could be seen when the embryo is about 6 days out.

L'ACCOUPLEMENT ARTIFICIEL CHEZ LES LEPIDOPTERES ET SON APPLICATION DANS LES RECHERCHES SUR LA FONCTION DE L'APPAREIL GENITAL DES INSECTES

par

Z.LORKOVIĆ

Zagreb, Yougoslavia

Summary

Partant du fait que les différentes parties du corps des insectes ont une autonomie fonctionnelle considérable, nous avons trouvé une méthode originelle d'accouplement artificiel des Lépidoptères. L'appareil génital est capable de fonctionner même après la séparation de l'abdomen du reste du corps; il l'est aussi si l'on écrase légèrement le thorax du papillon de sorte que celui-ci semble être mort. Si l'on appuie l'appareil génital mâle d'un abdomen ainsi séparé, ou celui d'un mâle écrasé, contre l'appareil génital d'une femelle qu'on a préalablement immobilisée, l'accouplement réussit facilement chez beaucoup de genres et d'éspèces de papillons. Le résultat d'une telle copulation est normal, car la femelle pond ultérieurement des oeufs fécondés.

Parmi les Rhopalocères, nous avons obtenu l'accouplement artificiel chez les Papilionidae, Pieridae, chez beaucoup de Nymphalidae, Satyridae et Hesperidae. Chez les papillons nocturnes, nous ne l'avons jusqu'à présent essayé qu'avec les Geometridae.

Cet accouplement artificiel est d'un grand intérêt. En effet c'est grâce à lui que nous avons obtenu des *élevages prolongés* s'étendant sur plusieurs générations chez des espèces dont l'accouplement en captivité ne réussit que difficilement, ou pas du tout (Papilionidae, Satyridae etc.). C'est aussi par cette méthode que nous avons obtenu l'accouplement dans des *circonstances défavorables* qui d'habitude l'empèchent: soit facteurs externes, tels que manque de lumière, de chaleur etc., soit facteurs internes tenant aux insectes: lésion du mâle, instinct sexuel affaibli chez le mâle, ou chez la femelle, accouplement d'une femelle déjà fécondée, etc. La méthode est surtout importante pour les *croisements entre les espèces*, car elle écarte les difficultés qui précèdent l'accouplement normal (odeurs sexuelles spécifiques). Ainsi nous avons pu obtenir presque tous les croisements possibles entre les espèces de *Pieris* européennes, certains *Euchloë*, *Erebia* et *Hesperia*.

L'application de cette méthode nous a donné des vues nouvelles sur la *fonction des différentes parties de l'appareil génital* et sur la valeur d'isolement des différences spécifiques de celui-ci. Nous avons pu constater que, chez beaucoup de genres et familles, les valves de l'appareil génital mâle ne jouent aucun rôle important et que, pendant l'accouplement, elles peuvent prendre des positions différentes et même rester inactives.

Dans certaines expériences nous avons changé la forme des valves en coupant une grande partie (1/3); cette ablation n'a pas eu d'influence sur la copulation, pas même chez les espèces ou les valves ont la fonction de tenir la femelle (Pieridae, Papilionidae). Ces expériences prouvent donc qu'on exagérait en affirmant que les appareils génitaux mâle et femelle devaient être faits l'un pour l'autre comme la serrure et sa clef.

Il s'en suit que la *valeur d'isolement* de la forme spécifique des appareils génitaux est loin d'être aussi importante qu'on le croyait jusqu'à présent; dans certaines parties de l'appareil génital les différences spécifiques n'ont aucune valeur pour l'isolement sexuel entre différentes espèces, par exemple chez les espèces du genre *Erebia*. Le rôle le plus important pendant la copulation est joué par l'uncus (avec les subunces) et celui-ci présente moins de différences spécifiques que les valves, qui n'ont pas autant d'importance pendant l'accouplement que l'uncus. Il est entendu qu'il ne faut pas faire de généralisation hâtive, parce que l'importance des différentes parties de l'appareil génital n'est pas la même chez les divers groupes de lépidoptères, et justement on pourra très bien démontrer cette particularité par notre méthode.

GENETIC DETERMINATION OF THE DEVELOPMENT OF THE DORSAL HYPODERM IN DROSOPHILA MELANOGASTER, AS STUDIED BY MEANS OF THE MUTANT TYPE "ASYMMETRIC" [1]

by

F.H.SOBELS

(Zoological Laboratory of the University of Utrecht, Netherlands)

In October 1949 we observed for the first time after washing out cultures of the strain *ltr/Inv.* *(3R + 3L)(lethaltranslucida, 3-21 +)* abnormal pupae, which were well differentiated but not able to emerge from their pupal cases. These pupae of viable genetic constitution were often characterized by partial or complete, but one-sided reduction of head, thorax or tergites. Therefore we called this aberrant type *Asymmetric*. The manifestation frequency of these aberrations, however, was very low.

After some generations of selection on head- and thorax-abnormalities we succeeded in isolating an abnormal pupa and in breeding an offspring from it.

Crossing with ***Dichaete*** *(D, 3-41 +)* and balancing this gene with ***Moiré*** *(Mé, 3-20 +)* and ***Stubble*** *(Sb, 3-58,2)* caused a remarkable increase in manifestation frequency for tergite-abnormalities. As in most cases this character, hence forth described as Abn. Abd. (Abnormal Abdomen) does not prevent the flies from emerging, we now had the possibility of breeding directly from abnormal flies. The rise in penetrance of Abn. Abd. was accompanied by increased frequency of the thorax- and head-aberrations. This fact as well as the striking morphological concordance between abnormalities in different body regions and the correlative connection between manifestation of Abn. Abd. and thoracal abnormalities all support the assumption that these abnormalities in abdomen, thorax and head are coherent phenotypic aspects of one underlying genetic basis.

Continued selection caused a slowly increasing frequency for Abn. Abd., which, however, after the 20th generation remained ±25.5%, from which 16% are males and 9.5% are females.

Replacement experiments with dominant marker genes for the different chromosomes carried out on an extensive material did not allow a positive conclusion as to the chromosomal localisation of the responsible factor. In all crosses, however, the favouring effect of ***Dichaete*** on manifestation frequency of Abn. Abd. is evident. When crosses to a wild type „Berlin Inzucht"-stock are followed by inter-se matings of F_1-Abn. Abd.-animals manifestation frequency in the F_2 is very low.

All these experiences make the conclusion of a polygenic determination of the Abn. Abd.-character highly probable. At the end of an article on an-

1) A more detailed account will be published in Genetica 1952.

other type of *Abnormal Abdomen (A, 1-4.5)* MORGAN (1915) notifies a mutant studied by BRIDGES, which shows a perfect resemblance to our tergite and thorax abnormalities. These authors also concluded to multiple-factor inheritance as a result of low penetrance in the F_2 after inter-se matingof the F_1-individuals.

Plasmatic or maternal determination can be excluded as reciprocal crosses continued during 4 subsequent generations gave no significantly different results.

We will now discuss the different types of abnormalities.

Abnormal Abdomen

We can distinguish the following main types of aberrations (fig. 1):

A. Mediodorsal disruption of one or more tergites.

B. Hemireduction of one or more tergites.

C. Apparently two tergites show hemireduction; the intermediate tergite(s) is shifted obliquely and fills the gaps between both of the half tergites.

E. Only the caudal pigmented border of half of a tergite has been developed.

F. Only the anterior part of half of a tergite has been differentiated.

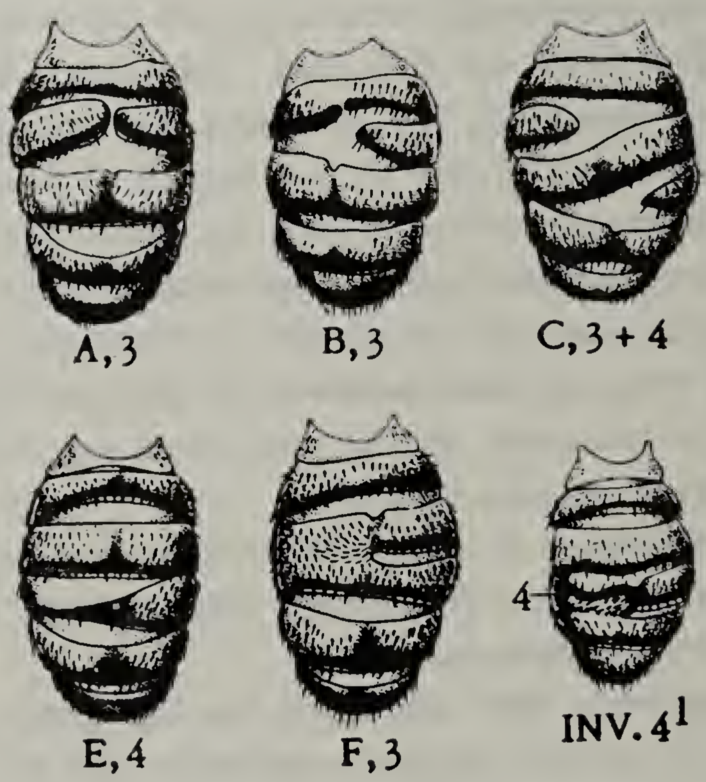

Fig. 1. Abnormal Abdomen, types A, B, C, E, and F; Inv. 4^1, left half of 4th tergite 180° inversed.

If there is any relation in morphogenesis of these seemingly totally different types of aberrations, our insight in the primarily disturbed developmental processes might be deepened.

Considering firstly the abnormalities only in flies, I was inclined to view the tergites and halves of tergites as individual independant elements. Reasoning in this way the question arose, whether the obliquely situated tergite of type C (fig. 1, type C 3 + 4) had to be considered as tergite 4 or if it would be composed of elements of tergites 3 and 4.

According to the first view the primary cause would be a failure in mediodorsal fusion of tergite primordium 3 (fig. 1, type A, 3). One of these two half-tergite „Anlagen" shifts underneath or past tergite 4 and differentiates in the gap arisen by the oblique position of tergite 4.

This view fits very well the observations on similar types of aberrations in head- and thoracal region, where probably after defective evagination and failure of mediodorsal union an asymmetrical dislocation of eye- or wingdisc takes place. At first sight it seems rather unlikely that half of a tergite-primordium possesses the ability to shift in the abdomen. From the drawing bottom right (fig. 1, INV 4^1) it becomes apparent, however, that half of a tergite may turn round 180° before or during imaginal differentiation. The rigid mosaic pattern of anterior and posterior region of half of a tergite, which will be discussed later on is also clearly demonstrated in this case.

According to the second view primarily both tergite primordia 3 and 4 fail to unite but then one half of tergite primodium 3 becomes attached to the opposite lying half of tergite primordium 4 and gives rise, by means of secondary fusion, to a complete and apparently unaffected tergite, obliquely situated between halves of the 3rd and 4th tergite. If, however, this second view holds true, it would be most probable that we should find also a considerable amount of cases where the original type A, 3 + 4 had been realized. In the same sample of 1240 Abn.Abd.-flies, however, the relative high frequency (57) of C, 3 + 4 corresponds badly with low frequency (9) of A, 3 + 4. A,3, however, shows highest frequency (200) of all types of Abn.Abd. for one special tergite. For this reason we then concluded that in most cases type C might be derived from type A according to the first-mentioned hypothesis.

However, if one takes larval segmentation aberrations into consideration, as we did later, by isolating young pupae with segmentation disturbances in glass vials with moistened filter-paper, one is inclined to pay more attention to intersegmental borders as separating the different body segments. According to this third view a primary mediodorsal interruption of the intersegmental border between segment 3 and 4 might be followed by a shift, although in opposite cephalocaudal direction, of both halves of this incomplete borderline. Metamorphosis will result in an imaginal aberration as represented in type C, 3 + 4. The fact that only one disrupted segmental border is needed to give rise to type C fits very well the statistical results mentioned above.

Considering now types E and F (fig. 1), it must be possible to conclude from reduction in antero-posterior (or inverse) direction, as demonstrated by these types that a "tergite anlage" is composed of a mosaic of two successive fields in antero-posterior localization with respect to each other. The mosaic character of this system becomes evident from the fact that with reduction of either anterior or posterior region the remaining part does not show regulation of the lacking one.

Absence of the caudal pigmented border (type F) is nearly always accompanied by a fusion with the succeeding half of a tergite. As this phenomenon

only happens in the region where pigment is missing, it may perhaps be assumed that formation of the posterior pigment border is necessary to prevent the fusion of different tergites.

The fact that all observed types of Abn.Abd. are already visible as aberrations of puparial segmentation (to be sure the puparium is the preserved cuticle of the 3^{rd} larval instar) gives evidence for their embryonic origin. This statement fits very well the findings of MAAS (1948) who produced phenocopies of several types of our hereditary Abn.Abd. during blastoderm formation (2nd-4th h.) and segmentation (8th-16th h.). We also observed both weakening and aggravation of pupal (larval) abnormalities during metamorphosis; according to HENKE, V.FINCK and MA (1941), there is also a sensible period for phenocopies during young pupal stages.

Abnormalities of the thorax

The thorax abnormalities consist mainly of two types of aberrations:

A. Incomplete mediodorsal fusion causes a "cleft" thorax. The wings and both halves of the dorsal mesothorax are normally developed (fig. 2, AT).

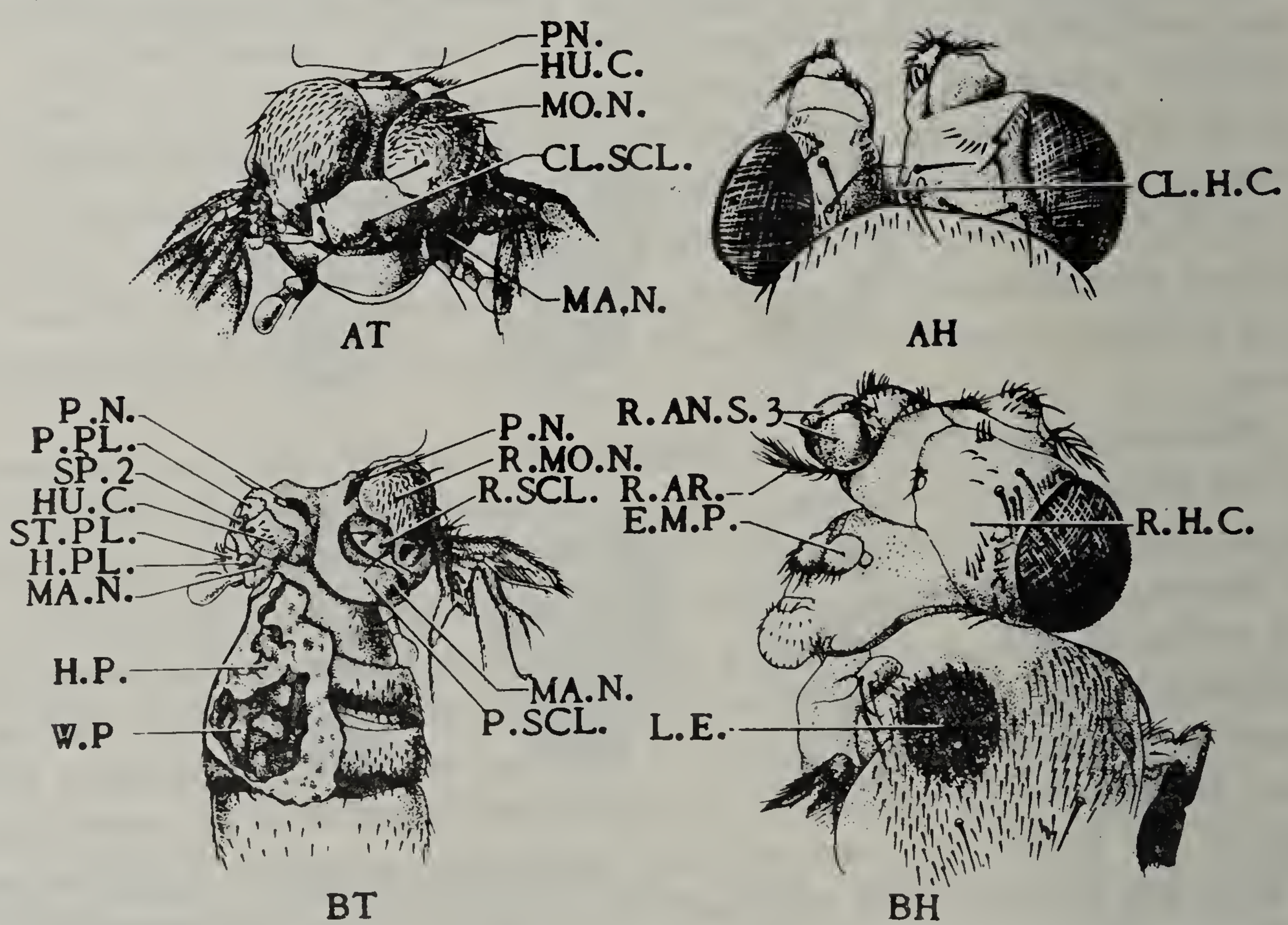

Fig. 2. Thorax- and headabnormalities; AT cleft mesothorax, BT hemithorax, AH cleft head, BH hemicephalic. CL.H.C., cleft head capsule; CL SCL, cleft scutellum; E.M.P., extra maxillary palpus; H.P., hypodermal part of mesothoracic discs; H.PL., hypopleurite; HU.C., humeral callus; L.E., left eye; MA.N., metanotum; MO.N., mesonotum; P.N., pronotum; P.PL., propleurum; R.AN.S.3, reduplicated 3^{rd} antennal segment; R.AR., reduplicated arista; R.H.C., right head capsule; R.MO.N., right half of mesonotum; R.SCL., right half of scutellum; SP.2, 2^{nd} spiracle; ST.PL., sternopleurite; W.P., wing part of mesothoracic disc.

B. A disturbance in evagination of one of the dorsal mesothoracic discs gives rise to the "hemithorax" type (fig. 2, BT). A complete reduction, however, of the derivatives of the dorsal mesothoracic discs has practically never been observed, as by dissection of abdomen and thorax, the missing part always could be located internally at that side of the body where the hemireduction occurred. Similar cases have been observed by LUDWIG (1938) in the "hemithorax" mutant of POPOFF (1937).

All sorts of transitional stages between these two principal types of aberrations with more or less incomplete evagination at one side are also found. Failure of evagination, however, is always accompanied with incomplete mediodorsal fusion.

A complete dislocation of the whole mesothoracic disc in caudal direction has also been observed. Evagination of hypodermal part and wing at a thin region of the integument at the end of the abdomen proved to be possible in this special case.

Structures belonging to the 1st and 3rd thoracal segment are never implicated in these aberrations.

The mesothoracic spiracle which in normal animals is situated in the mesopleurum (FERRIS, 1950), at the atrophied side of the "hemithorax" flies is always developed but situated either in the propleurum (SCHULTZ, 1938 made the same observation in his "hemithorax"-*vestigial*-flies) or in the hypopleurum. In Abn. Abd. type B with hemireduction of tergites, spiracles have also developed normally. Both observations prove that the tracheal spiracles develop independently from hypodermal differentiations.

Head abnormalities

The aberrations of the head have much in common with those of abdomen and thorax.

A. Incomplete mediodorsal fusion of the head capsule gives rise to a cleft or split head (fig. 2, AH).

B. A type, which I called "hemicephalic" may originate, if evagination of one of the eyediscs (in fact the dorsal head disc) does not happen (fig. 2, BH). These hemicephalic flies demonstrate clearly that besides the eyes the whole dorsal head capsule is formed by the eye imaginal discs. Just as in the hemithorax flies the non-evaginated wing was mostly present, in cases of "hemicephaly" we could observe the missing eye in the thorax. Here also secondary dislocation may occur as became evident from the case of a hemicephalic fly with an eye in the abdomen (clearly recognizable by the lively red colour shining through the body wall).

As was mentioned before, discussing thorax aberrations, intermediary stages with one-sided incomplete evagination of eye – or hypodermal region or both – may occur here also.

Attention should be paid to the typical antennal reduplications. Some of them will probably be regulative reduplications, provoked in a purely mechanical way by disturbance in mediodorsal fusion or by abnormal replacements

of other organs in this region. Hence some of the reduplications might be compared to those, arisen from damage, after experimental sectioning followed by transplantation (VOGT, 1946).

Experimentally reduplications of antennae and eyes may be induced till the 2nd half of the 3rd larval instar (VOGT, 1946, 1947). From this it might be concluded that the genetically determined head-aberrations, often accompanied by reduplication of antennae and palpi, should be determined before the 2nd half of the 3rd larval instar.

Summarizing we may state that our work with the mutant type "Asymmetric" proves the genetic determination of development of the dorsal imaginal hypoderm. The genes involved in these processes act on evagination of dorsal imaginal discs and dorsomedian fusion of the hypoderm. It is evident that these two processes must be closely correlated. Many facts point to the common genetic base, which is of polygenic nature, of the aberrations in head, thorax and abdomen. Therefore it may be concluded that for a harmonious development of the dorsal hypoderm in the normal fly a coherent system of polygenic factors is also responsible.

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DISCUSSION

Mr. **Burtt**: When do you think these abnormalities begin to act?

Mr. **Sobels**: The tergite abnormalities will probably arise during the embryonic stages, as they are already present in the larval cuticle (puparium). This observation is in accordance with the experimental dates of MAAS (1948), who produced pure phenocopies of our Abn.Abd. during blastoderm formation and segmentation.

The "regulative" duplications of the antennae give evidence for a determination of the head abnormalities before the second half of the third larval instar (cf. VOGT, 1946).

Mr. **Boumhiol**: Are all your abnormalities genetically determined and reproducable in succeeding generations?

Mr. **Sobels**: Yes, the different abnormalities are always reoccurring in my DxcF/MeSb-stock inbred during many generations for Abn.Abd.; although manifestation frequency for thorax- and head aberration is very low as compared to penetrance of 25,5% of Abn.Abd.

Furthermore manifestation of Abn.Abd. is highly dependent from the presence of the *Dichaete*-chromosome. In crosses this is clearly demonstrated by dominance of Abn.Abd. in the *Dichaete*-classes.

SYSTEMATICS AND CYTOGENETICS IN ANOPHELINES

by

C. JUCCI,

Pavia, Italy

RUSSEL, ROZEBOOM and STONE in the Introduction to their "Keys to the Anopheline mosquitoes of the world" (1943) assert that "no one knows exactly what should constitute a species, a variety or a race of mosquitoes". That is a quite good picture of the situation.

The needs of the malaria control stimulated detailed observation of the epidemiologic distribution (anophelism without malaria); discovery of peculiar ecological behaviour (e.g. the so-called misantropy) followed and on this ground could be discriminated "biological races" in the species *A. maculipennis* Meig.

The study of these races was too difficult, however, without differential morphological characters as guide. Great progress was made by MARTINI, MISSIROLI and HACKETT (1931) when they gave full worth to the egg characters discovered by FALLERONI (1926). Differential characters were also found in larval chetotaxis – with large fluctuations they are unsuitable for individual diagnose – and in imaginal characters: wing pattern in females and genital terminalia in males. In the mean time breeding experiments demonstrated that not only biological races, but even specific entities were present. So *maculipennis* turned out to be a group or complex of species, and even it was possible to attempt an estimation of their systematic affinities.

The needs of the malaria control are continuously requiring further detailed biological survey; so new problems arise, new puzzling phenomena come to light and in order to explain them a new method of investigation appears necessary.

The discovery that it is possible to study the structure of salivary chromosomes of Anopheles just as in Drosophila, opened the way to true population genetics of malaria mosquitoes.

Already the results obtained along this new line in the Institute Spallanzani of Pavia by Dr. FRIZZI, are interesting. For each unit of the *maculipennis* complex (the so-called races) a peculiar, characteristic arrangement of the chromosomic set, present in homozygous state in every individual of the races, has been found. This situation appears different from that usually found in *Drosophila*.

In *Drosophila* often a geographic and seasonal polymorphism is found, which though there is a high frequency of structural heterozygotes, does assure a great plasticity of adaptation to environment (DOBZHANSKY and others). In *Anopheles* a comparable degree of plasticity is attained by means of variation of the numerical composition of the racial components of the

group. In one of these units, however, the *A. messeae* Falleroni, FRIZZI has found a chromosomic dimorphism.

Correlation between chromosomic structure and egg characters, in *messeae* has been searched by us but not found. So we do not feel authorized to admit the coexistence, under the name *messeae*, of two distinct taxonomic entities.

In the course of the study such a complexity of variations in the egg characters has been found, that the systematic diagnosis, based on such characters, appears to some degree schematic and too much simplified.

In the detailed study of the populations, in various localities and in various seasons, the chromosomic structure has been examined in correlation with the egg characters, analytically studied, and also with the larval characters-like branching of the antepalmate hairs. We intend to study also the effect of crossing forms with various chromosomic structure. It is too early to conclude what will be the result of the studies undertaken in the Institute Spallanzani, but there is no doubt about the usefulness and fertility of the cytogenetic approach.

In several cases of unusual behaviour, at first glance inexplicable – e.g. variation of the importance of a given vector in given geographic or ecologic sectors – responsability is attributed to extrinsic causes. In some other cases, on the ground of egg characters, a racial differentiation has been suspected.

Exploring the structure of the salivary chromosomes we have the possibility of determining the genetic basis of the racial differentiation; and comparing these results with the ones reached along other lines, the possibility is open of discriminating what is due to the genetic mechanism of differentiation, isolating and the like, and what is due to competition with other mosquitoe species, local biological equilibria, factors of the agrarian and urban human environment etc.

Of course, also in this case, when extrinsic factors appear responsable for the changed behaviour of the species, in the long run genetic variations could follow.

For instance let us assume that *labranchiae* Falleroni diffusion in Sicily in every kind of waters is a consequence of the freedom from competition of northern forms, this does not exclude the existence in this island of various differentiated races of *labranchiae* adapted to different environments.

I have confidence in the possibility of exploring by this cytogenetic method the mechanisms of differentiation; attacking the problem if such variability of the chromosomic structure is caused by biological isolation in peculiar ecological situations or if they determine themselves such situations by their physiological value.

Also the problem of the morpho-physiological correlations (recently discussed by HOWANITZ) is important with regard to the significance of these chromosomic arrangements and of the value of genic pleiotropism and linkages in determining such correlations.

The results already achieved in the comparative cytogenetic studies of the various forms of the european *maculipennis* complex authorize us to suggest the usefulness and fertility of the application of the same method – the analysis of the salivary chromosomes first in the neartic forms of the same complex – *occidentalis* DYAR & KNAB, *freeborni* AITKEN, *aztecus* HOFFMANN, and in near species like *quadrimaculatus* SAY, in the puzzling groups of species found not only in *Anopheles* sensu stricto but also in other sections of the genus, like *Myzomyia* and *Nyssorynchus*.

I am sure that such a cytogenetic study will prove extremely useful for the systematics of Anophelines, and of course also for their biology and consequently for malariology.

DISCUSSION

Mr. **Sobels**: What is your explanation of the fact that in contrast to *Drosophila*, in which inversions practically only appear in heterozygotic condition, the different *Anopheles*-species mostly show homozygotic inversions?

Mr. **Jucci**: The difference of behaviour is probably connected with some basic differences in elementary chromosomic mechanisms like the differences in crossing-over behaviour already known between Brachycera and Nematocera. Dr. FRIZZI has just in program a thorough research in this line.

As a matter of fact, very seldom even in *messeae* heterozygotic condition occurs in *A. maculipennis*. One could say that the method of reaching a high plasticity of adaptation to environment is very different in *Drosophila* and in *Anopheles*.

Mr. **Holst Christensen**: I thank you very much for your interesting lecture. I should like to ask you how your fine preparations have been made. I suppose they are smear-preparations? Can you tell me in which way they have been stained? Have you used acetic carmine or eventually acetic orcein (La Cour)?

Mr. **Jucci**: The preparations were made with the smear methods most currently used in *Drosophila* cytogenetics: aceto-carmin etc.

Only Dr. FRIZZI, who actually made the research, could indicate every detail of the technique. I can say that for the success are important not so much the modifications of the usual smear method as the optimal growth of the larvae reached, controlling temperature, pH and food. That explains why eminent cytologists who did try the study of salivary chromosomes of mosquitoes, did not succeed. Only few cells, however, of the salivary glands, show a clear structure and only with them one can work.

DIE BEDEUTUNG DER POSTEMBRYONALEN ENTWICKLUNG FÜR DIE PROTOMORPHA (COLLEMBOLEN)

von

Eduard HANDSCHIN

Basel, Schweiz

Im allgemeinen wird das Larvenleben der Insekten als deren längste Lebensperiode bezeichnet, welche sich in eine mehr oder weniger grosse Anzahl von Stadien einteilen lässt, die jeweilen durch Häutungen voneinander getrennt werden. TILLYARD führt u.a. an, dass die grössten Häutungszahlen bei Ephemeriden und Odonaten mit 11 bis über 20 anzusetzen seien, während bei andern Familien 6 Stadien kaum oder nur sehr selten überschritten werden; MURPHY weist indessen für *Baetis posticus* 27 Häutungen nach und nach SCHÖNEMUND's Angaben soll *Perla cephalotes* in der 3 Jahre dauernden Entwicklung 27-43 Mal das Kleid wechseln. Es darf nun wohl aber für die Insekten allgemein als Gesetz gelten, dass mit der letzten Häutung das Wachstum abgeschlossen ist, d.h. Geschlechtsreife erreicht und damit das Imaginalstadium erreicht wird. Dabei sind mit einer Ausnahme die Larvenstadien flugunfähig. Bei den primitiven Ephemeriden ist das vorletzte Stadium, die Subimago, bereits geflügelt ohne indessen geschlechtsreif zu sein.

Während nun bei den epimorphen und anamorphen Arthropoden – über die zu den letztem gehörenden Proturen hat uns in jüngster Zeit TUXEN orientiert – in ihrer postembryonalen Entwicklungsweise bekannt sind, existieren über die protomorphen Collembolen noch sehr wenig zuverlässige Angaben, die uns gestatten ein klares Bild über die Vorgänge zu erhalten, die sich während des postembryonalen Wachstums abspielen. Wohl wurde bei gelegentlichen Beobachtungen festgestellt, dass sich bei den verschiedenen Arten Eischübe und Häutungen ablösten, mit andern Worten, dass die Häutungen im postadulten Zustande, der sonst für die andern Insekten das langsame Auslöschen der Lebensfunktionen bedeutet, weiter gingen. Ob aber und wie sich hier ein bestimmter Rhythmus in die Lebensweise einordnen könnte, blieb unklar. Und doch schien gerade diese Frage von besonderer Wichtigkeit, nicht blos als Tatsache an sich, sondern wegen den andern bemerkenswerten Faktoren, welche die systematische Stellung der Collembolen so ganz besonders zu unterstreichen im Stande sind.

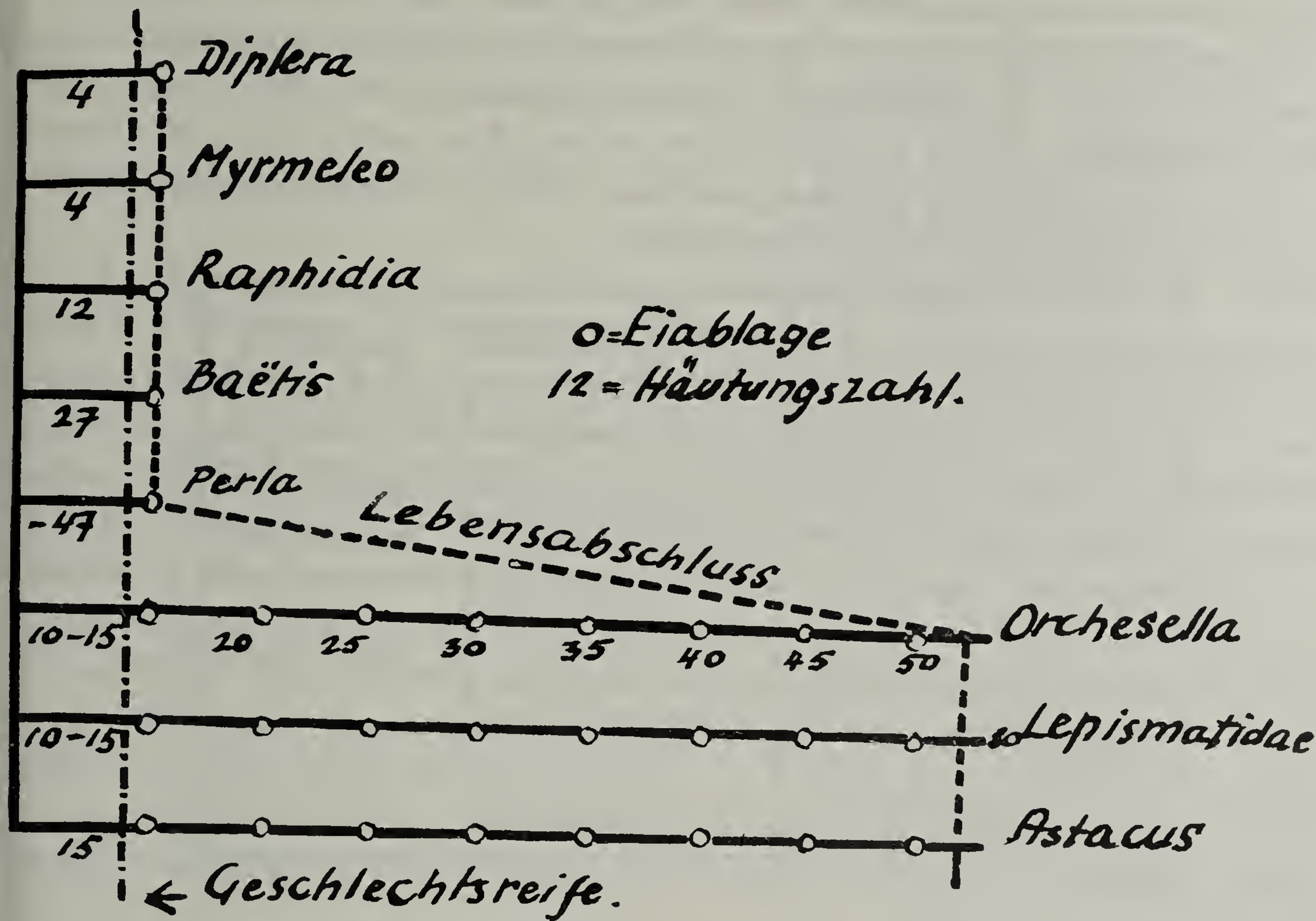
Um nun die hier fehlenden Beobachtungen zu ergänzen, liess ich durch meinen Schüler W. LINDENMANN Zuchten an Collembolen durchführen. Dazu mussten besonders grosse Arten ausgesucht werden. Als günstige Objekte wurden deshalb die Arten der Gattung *Orchesella* gewählt, die einmal überall und zu jeder Zeit leicht erhältlich und die leicht zu züchten waren. Der Grund zur Wahl dieser Gattung war allerdings ein anderer. Es sollte gleichzeitig die Entwicklung des Farbmusters genau beobachtet werden, um so eventl. die phylogenetischen Zusammenhänge der einzelnen Arten festlegen

zu können, da die Variabilität in der Zeichnung gerade bei einzelnen alpinen Formen ganz ausserordentlich gross waren und Übergänge zwischen den verschiedenen Formen zu existieren schienen.

Die bei diesen Zuchten erhaltenen Resultate lassen sich nun folgendermassen zusammenfassen:

Die aus dem Ei schlüpfenden Collembolen häuten sich in dem ca. 1 Jahr dauernden Leben etwa 50 Mal, je nach den verschiedenen Arten. Die dabei innegehaltenen Häutungsintervalle schwanken zwischen 2 und 29 Tagen. Sie sind in erster Linie von der Temperatur abhängig. Bis zur Zeit der ersten Eiablage legt das Tier 12-15 Häutungen hinter sich. Die dazu gebrauchte Zeitspanne beträgt 33-184 Tage. Der zeitliche Ablauf der Reife ist demnach in erster Linie an das Erreichen einer bestimmten Häutung gebunden und nicht an die Zeit, d.h. diese verlängert sich bei tiefen und verkürzt sich bei hohen Temperaturen nach den normalen Gesetzen der Temperatur-Reaktionsgeschwindigkeits Regel. Wenn nun die Geschlechtsreife erlangt und die erste Eiablage erfolgt ist, geht das Tier nicht zu Grunde, wie dies bei den übrigen Insekten der Fall ist, es häutet sich im normalen Rhythmus weiter. Trotzdem es die Geschlechtsreife erlangt hat, wächst es aber dabei weiter und zwar nimmt es bis zur 20-25. Häutung noch um 60-70% an Grösse zu. Die maximale Grösse wird etwa bei der 25. Häutung erreicht. Von der 25. bis zur 50. oder letzten Häutung ist das Längenwachstum ganz minim, noch ca. 10% und kaum in Frage kommend (Grösse beim Schlüpfen 0.45 mm, Geschlechtsreife 3.05 mm, 25. Häutung 4.05-4.3, 50. Häutung 4.5 mm). Die Zeitspanne bis zum Erreichen der Geschlechtsreife beträgt also 1-5 Monate, 1-2 Monate später wird die volle Grösse erreicht und überdies leben die Tiere noch 5-6 Monate weiter bis zum Eintritt des Todes. Während dieser letzten Lebensperiode vollziehen sich nun spezielle Vorgänge. Einmal erfolgen nach durchschnittlich 5. Häutung jeweilen neue Eischübe und zwar werden jeweilen 4-8 Eier abgelegt, sodass im ganzen von einem Individuum etwa 60-80 Eier deponiert werden. Copulation konnte keine beobachtet werden, hingegen ist parthenogenetische Fortpflanzung sicher erwiesen.

Als weiterer wichtiger Punkt ist aber hervorzuheben, dass während der letzten Phase des Lebens, vom Zeitpunkt an, wo die maximale Grösse erreicht ist, eine Veränderung im Farbkleide der Tiere vor sich geht. Sie beginnen einzudunkeln. Zunächst findet allgemein eine Verdunkelung der ganzen Körperfläche statt, gleichsam des Untergrundes, welchem später ein Ausbreiten der dunkeln Zeichnungselemente folgt, bis schliesslich beide zusammen fast die gleiche Tönung aufweisen oder die Tiere ganz schwarz werden. Endlich muss noch erwähnt werden, dass die Männchen weniger Häutungen durchmachen als die Weibchen, also früher sterben und dass sie weitaus stärkere Farbveränderungen aufweisen als die Weibchen, deren Kleid nahezu constant bleibt und die Farbe des maximalen Wachstumsstadiums aufweisen.



Die Tatsache der postadulten Häutungen bei den Collembolen findet nun nirgends bei den Hexapoden eine Parallele *). Wohl existieren nun Insekten bei denen eine grosse Häutungszahl nachgewiesen worden ist. Aber bei allen bedeutet das Erreichen des Imaginalstadiums den Eintritt in die Geschlechtsreife, das Erreichen der maximalen Grösse und damit den baldigen Eintritt des Todes. Nicht so bei den Collembolen, bei denen Wachstum, Häutungen und Reifperioden weiterfolgen, in ähnlicher Weise, wie wir sie bei den Crustaceen kennen. Bei diesen, speziell bei *Astacus* und verwandten Formen tritt die Geschlechtsreife in der Regel mit dem 4. Jahre ein. Dieser gehen im ersten Jahre 6- 10, im zweiten 5 und im 3. vier Häutungen voraus. Der Krebs wird also mit ca. der 15. Häutung geschlechtsreif. Wenn diese erreicht ist, gehen auch hier die Häutungsvorgänge weiter und zwar sollen die Männchen sich zweimal, die Weibchen einmal im Jahr häuten und ihr Leben soll mit ca. 20 Jahren abgeschlossen sein. Dies würde also etwa 47-50 Häutungen ausmachen, wodurch die Parallele zu den Collembolen besonders unterstrichen wird. Die protomorphen Collembolen erreichen wie schon oben ausgeführt mit der 15. Häutung die Geschlechtsreife. Wachstum und Häutung gehen weiter und finden zwischen der 40. und 50. Häutung ihren Abschluss.

*) SWEETMAN hat hingegen auf dem IX. int. Ent.Congress in Amsterdam über Züchtungsversuche an Lepismatiden berichtet, welche zu absolut gleichen Resultaten führten, wie LINDENMANN sie an Orchesellen erzielte. Thysanuren und Collembolen scheinen sich also bedeutend näher zu stehen, als z.B. Collembolen und Proturen.

Doch besteht auch gegenüber diesen eine wesentliche Differenz, indem bei den Collembolen embryonal und postembryonal die gleiche Segmentzahl im Abdomen vorhanden ist, während die Cruster insgesamt sich durch ihre Anamerie auszeichnen. Die Collembolen sind die einzigen Protomorpha, welche bis jetzt bekannt geworden sind. In dieser Hinsicht stellen sie sich allen andern Arthropoden gegenüber.

Wenn wir nun alle Faktoren, welche zur systematischen Trennung verschiedener Insektenklassen in Betracht kommen, berücksichtigen und andererseits das Verbindende gegenüberstellen, so finden wir eigentlich mit Ausnahme einer scheinbaren Hexapodie keine gemeinsamen Züge zwischen Collembolen und Hexapoden, an deren Basis sie stets gestellt werden. Sie haben demnach als besondere Klasse ausserhalb des Hexapodenreiches zu stehen, mit denen sie, ausser der 6 thoracalen Beinen, nichts gemeinsam haben.

Diese Besonderheiten, welche die Collembolen auszeichnen, sind folgende:

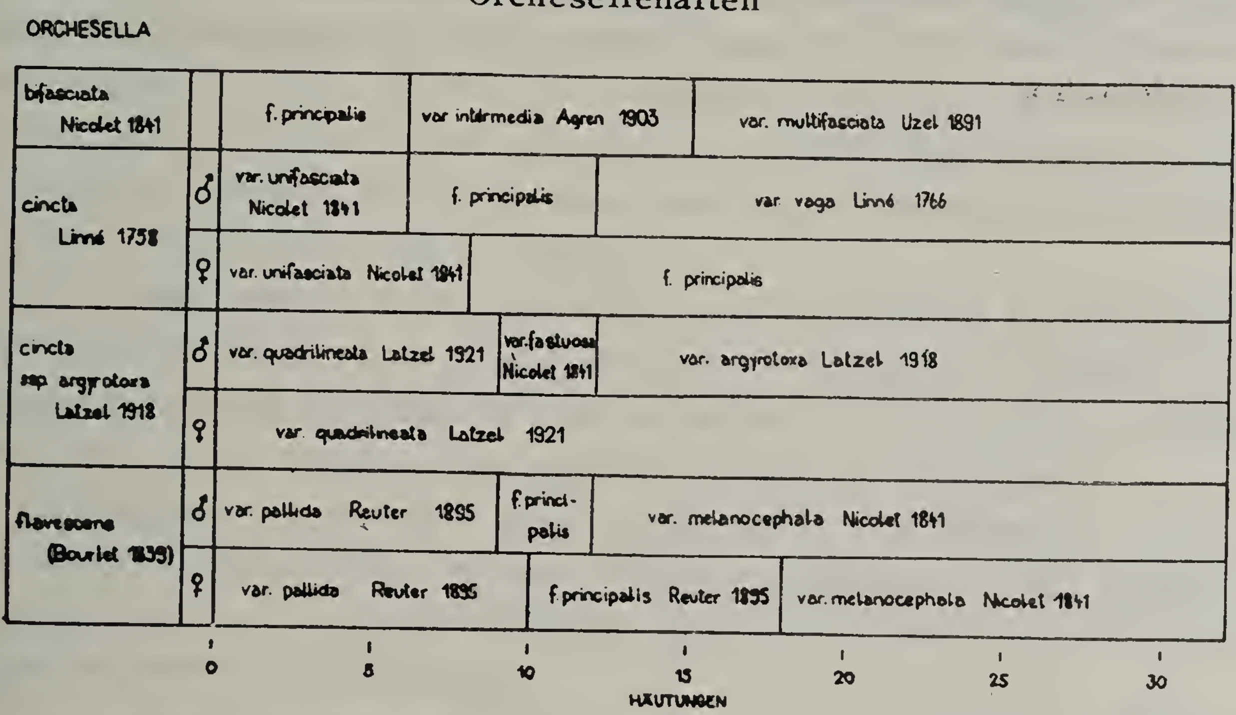
1. Der eigenartige Bau der Gonaden und der Eireife.
2. Die telolecithalen Eier mit anfänglich totaler und aequaler Eifurchung.
3. Die minimale Segmentzahl des Abdomens, welche während der ganzen Entwicklung weder Vermehrung noch Reduktion erfährt (Protomorphose).
4. Die Anlage abdominaler Beianlagen, von denen mindestens eine noch der Fortbewegung dient (Furca).
5. Das nach der Erreichung der Geschlechtsreife weiter andauernde Wachstum mit zahlreichen postadulten Häutungen.
6. Das Fehlen der vasa malpighii.
7. Das hohe geologische Alter (*Rhyniella* aus dem Devon).

Alle diese differenzierenden Merkmale gestatten uns den Collembolen oder Protomorpha (nach TILLYARD) einen Platz an der Basis der Arthropoden zuzuweisen und zwar haben sie vor die Chelicerata gestellt zu werden, wo sie mit den Thysanuren eine parallele Entwicklungsreihe darstellen, die ohne weitere Verbindung nach oben abbricht. Dabei ist zu betonen, dass die Verbindung mit den Thysanuren durch die Untersuchungen von SWEETMAN wohl angezeigt wird, dass hingegen sowohl für *Ectotrophica* wie *Endotrophica* die Embryonaluntersuchung erneut aufgegriffen werden muss um hier um Epimorphie, bezw. Protomorphie Aufschluss zu geben. Anderseits reihen sich dann die *Anamerentoma* ebenso an die Basis der Myriopoden zwischen diese und Cruster ein, gleichermassen als kleiner Einzelast, der ebenfalls nur eine sekundäre Hexapodie, sonst aber keine Verwandtschaft mit den Hexapoden i.r. Sinne erlangt hat. Auf all diese Frage soll eingehend in einer speziellen Arbeit berichtet werden.

		Collembola	Endothrophica	Ectothrophica	Crustacea	Protura	Myriopoda	Hexapoda
Typus der Entwicklung	protomorph	x	?	?				
	anamorph		?		x	x	x	
	epimorph		?	?			x	x
Typus der Eifurchung	total, aequal.	x	?					
	superfic, inaeq.		?	x	x	x	x	x
Hautungen	postadult weitergehend	x	?	x	x	?		
	nur bis matur					?	x	x
abdominale Polypoidie	vorhanden	x	x	x	x	x	x	
	fehlend							x

Auf eine letzte Erscheinung sei hier noch verwiesen, welche innerhalb der Collembolensystematik ihre Bedeutung hat, — auf die Veränderung des Farbkleides postadult, und dann auf die Differenzen in der Tracht zwischen männlichen und weiblichen Tieren, In verschiedenen Gattungen bleiben die morphologischen Merkmale, welche zur Bestimmung wichtig sind, einzig in der Beurteilung des Farbmusters. (*Isotoma, Entomobrya, Sira, Orchesella, Salina, Paronella*). Bei solchen Formen galt es bis jetzt, die Musterung genau zu analysieren oder viele Tiere von ein und demselben Standorte zu be-

Zusammenstellung der Zeichnungsentwicklung verschiedener Orchesellenarten



trachten. Dabei sind viele Formen und Varietäten beschrieben worden, deren Aufrechterhaltung nach den vorliegenden Untersuchungen nicht möglich ist. Die Collembolen wechseln bis zu einem gewissen Grade ihr Farbkleid während ihres Wachstums und speziell ändern sie Farbe und Kleid nach der Erreichung der Geschlechtsreife, sodass für ein und dieselbe Art Jugend und Alterskleid verschieden sind, und auch verschiedene Benennung erfahren haben.

Alle Formen, welche so Beschreibung erfahren haben, müssen zu Gunsten der Bezeichnung der Adultform eingezogen werden. Dies bedingt aber, dass für die meisten dieser Gattungen, die einzelnen Formen einmal durchgezüchtet werden müssen, damit die Zusammengehörigkeit der einzelnen Arten richtig fixiert und festgestellt wird.

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DISCUSSION

Mr. **Tuxen**: Nach der Entwicklung, Protomorphie und Anatomie, wären vielleicht die Collembolen und Proturen weit von einander zu stellen, nach der Morphologie, speziell der Mundteile, sind sie sehr nahestehend. Würden Sie den entwicklungsgeschichtlichen Besonderheiten mehr Gewicht beilegen als den morphologischen oder nur den gleichen?

Mr. **Handschin**: Die Formen stehen wohl weit von einander entfernt und sind als Parallelstämme der Entwicklung aufzufassen. Die Mundteile als solche würde ich als zu leicht modifizierbar nicht zu sehr ins Gewicht fallen lassen.

R DES FEMELLES MICROPTERES DE THAUMATOPOEA PITYOCAMPA SCHIFFM. (LEPIDOPTERA) OBTENUES EN ELEVAGE

par

Jean LORITZ

Nice *)

Les formes microptères et aptères de certains Lépidoptères posent des blèmes divers dans les domaines de la physiologie et évolution de ces èces. Il est avant tout étonnant que seules les Psychides et quelques èces parmi les Géométrides furent frappées par cette modification mor-logique profonde qui est la réduction quasi totale ou même totale des anes macroscopiquement les plus caractéristiques de l'Ordre des Lépi-tères, à savoir les appendices membraneux, les ailes.

lucune espèce de Rhopalocères du Globe ne fut jusqu'à présent touchée les processus qui ont présidé à la formation d'ailes rudimentaires, trans-es aux générations suivantes.

'armi les Géométrides (vulgo sensu) dont on connait plus de 1500 bonae cies de la Zone palaearctique (une liste complète manque encore), seule-t quelques-unes possèdent des ♀♀ microptères ou aptères.

i *Apocheima hispidaria* Schiffm., à laquelle advient systématiquement lleurs une autre place que celle que l'on lui attribue communément, pos-: une ♀ aptère, les espèces phylogénétiquement les plus proches par re, comme *Lycia hirtaria* Clerck et *Biston strataria* Hufn. possèdent des parfaitement ailées et semblables aux mâles.

a rareté de l'atrophie des appendices membraneux chez les Lepido-es, frappant une espèce, épargnant toute la série des espèces de plus he apparentée, nous autorise à admettre un terrain intrinsèque propre à èce. C'est cette disposition spécifique favorable à l'action élective de urs extrinsèques qui nous semble expliquer l'apparition isolée, et spon-e de l'atrophie des ailes.

ais étant donné que chez toutes les espèces en question uniquement la lle fut frappée, ne doit-on pas présumer un substratum physiologique, e à la femelle, fonction de l'organisme sexuel, et favorisant l'atrophie uatre ailes, à laquelle le mâle a résisté?

en que cela nous semble être un postulat pour comprendre ce phénomène isivement unisexuel, nous ne possédons pour le moment, cependant, pas nnées précises dans le domaine des hormones de la chenille, la chry-e ou de l'imago pour exprimer ce postulat en formule chimique.

ns la genèse des ♀♀ aptères nous considérons ces formes, avec la ité des auteurs, comme des relictes d'ailes autrefois de taille normale. e trouvaille récente, la première de ce genre citée dans la littérature, à l'appui de cette interprétation.

:hor not present at Congress; published by courtesy of the editorial committee.

SARLET, L. a décrit in Lambilliona XLVIII Nos. 9-10, Bruxelles 1948, ps. 78-79 une ♀ d'*Erannis leucophaearia* Schiffm. trouvée près de Liège, et qui possède un aileron gauche de 4 mm. d'envergure, tandis que l'aile droite „paraît inexistante". Les ♀♀ de cette espèce sont ou aptères ou microptères. Nous souscrivons volontiers à l'interprétation de L. SARLET qu'il s'agit dans la ♀ de Liège d'un atavisme dans la forme ancestrale.

Formes à Ailes Réduites non Estropiées, obtenues en Élevage.

Ce sous-titre demande un mot additionnel. Nous entendons sous le terme „estropiées" des papillons qui après l'éclosion n'arrivent pas à étendre normalement les ailes, partiellement roulées, chiffonées, ou collées. Bien entendu, il ne s'agit pas de telles formes dans les lignes suivantes.

Pendant plusieurs années nous avons fait des élevages de *Saturnia pavonia* L., *Ocneria dispar* L. et *Thaumatopoea pityocampa* Schiffm. en nourrissant les chenilles ab ovo ou dès leurs premiers stades, avec des feuilles déshydratées par dessication au soleil et en privant les larves d'eau d'arrosage. L'humidité à la disposition de leur métabolisme etait exclusivement celle qu'offrait l'etat hygrométrique de l'air de Nice, à un endroit exposé au soleil et protégé contre la pluie et la rosée.

Les résultats de ces expériences variaient suivant l'espèce.

Longueur de l'aile antérieure droite:

	♀ normale	♀ élevage	♂ normal	♂ élevage
Sat. pavonia	40-42	30-31	32-33	31-33
Ocner. dispar.	31-32	22-23	25-26	20-21
Thaumatopoea pityocampa	17-18	2-3	16-18	11-13

Bien qu'à ces chiffres n'advienne pas une valeur absolue, ils résument pourtant la différence graduelle des résultats obtenus.

Chez *Saturnia pavonia* L. les ailes des ♂♂ ne furent que peu réduites sauf dans un cas (27 mm). Chez les ♂♂ d'*Ocneria dispar* L., la réduction etait plus prononcée et accompagnée d'une coloration et de dessins diminués. Les ailes étaient plus ou moins diaphanes.

DUMONT C. avait obtenu des ailes extrêmement diaphanes en alimentant des chenilles du petit Arctiide *Ocnogyna fuliginosa* L. avec des carottes fraiches.

Les ailes des ♀♀ des deux espèces *Sat. pavonia* et *Ocn. dispar,* comme les chiffres comparatifs le démontrent furent, bien que les ♀♀ soient plus grandes que les ♂♂, beaucoup plus réduites que celles des ♂♂, Les ♀♀ d'*Ocn. dispar* L. présentaient aussi une diminution de traits et points noirs en nombre en taille.

C'était avec *Thaumatopoea pityocampa* Schiffm. que furent obtenues véritables formes microptères.

Un nid contenant des chenilles du Processionnaire du Pin, ayant fait l

première mûe, fut séparé de l'arbre en sciant la branche sur environ 50 cm. de long. Après avoir enlevé toutes les aiguilles, la branche avec le nid fut fixée sur une autre branche de Pinus maritimus Lam. préalablement soumise à une dessication par le soleil telle que les aiguilles fânées commençaient à tomber. Ni la branche, ni le nid avec les chenilles ne furent jamais arrosés d'eau ni exposés à la pluie. Jusqu'à la chrysalidation, il en a fallu 14 branches désséchées.

A l'éclosion, la taille du cephalothorax et de l'abdomen ne différait guère de celle d'imagos normaux. Il n'y a pas eu des formae nanae.

Les ailes des ♀♀: Sur 25 éclosions dont 14 ♀♀ et 11 ♂♂ les ailes antér. des ♂♂ atteignaient 11 à 13 mm de longueur. Chez 9 ♀♀ se présentaient *les ailes comme des mégots* dont les plus rudimentaires mesuraient chacune de 2 à 3 mm de longueur, à peine plus longues que larges. Les ailes postér. atteignaient 1 à 2 mm de longueur. C'est donc la femelle dont une aile normale antér. mesure environ 17-18 mm de long., qui fut de loin la plus frappée par l'atrophie.

Ci-dessus photos taille naturelle d'un spécimen pris près de Nice et une ♀ microptère d'élevage.

Les extrémités, en gardant à peu près leur longueur normale, étaient plus grêles, les palpes et les antennes un peu plus courtes. Les écailles qui couvraient densément les ailerons n'avaient pas changé de couleur sous l'influence de la nourriture deshydratée.

Comme on le voit, la nutrition déficiente par une modification du rapport entre cellulose, substences inorganiques et sève des aiguilles du Pin, a particulièrement frappé les organes appendiculaires du corps, les plus éloignés du centre de nutrition, les ailes.

Pour expliquer les causes de cette dégradation structurelle qui a donné *dans la nature* naissance à des ♀♀ microptères ou aptères, quelles hypothèses peut-on évoquer? S'agit-il de mutations, d'un non-usage des ailes, d'une sélection naturelle ou d'une misère physiologique par carence alimentaire?

Mutation - La ♀ aptère est-elle la phase initiale ou terminale dans l'évolution de ces espèces?

Nous la considérons avec la majorité des auteurs, comme phase terminale, mais brusquement apparue.

On connait actuellement dans la zone paléarctique environ une quarantaine d'espèces Géométrides a ♀♀ aptères ou microptères; nombre infime

par rapport à cette grande famille. L'apparition isolée, sans stades intermédiaires, chez les espèces les plus proches, peut être interprétée comme effet d'une mutation.

MORGAN TH. H. a vu naître et devenir souche d'une nouvelle race de formes aptères et microptères chez *Drosophila melanogaster* Mg. La majorité des mutations obtenues par lui portait d'ailleurs sur les ailes de ce minuscule Diptère, dont la taille est de 2 à 3 mm. La longueur d'une aile antér. d'un ♂ d'une *Géométride* à ♀ aptère, se situe entre environ 16 à 23 mm, différence respectable par rapport à une *Dros. melanogaster* Mg.

Nous nous refusons à considérer des mutations d'animaux même de si petite taille, à plus forte raison celles frappant des espèces beaucoup plus grandes, dans notre cas des Lepidoptères, comme produit d'un hasard aveugle, thèse si chère à plusieurs mutationistes.

Si on admet une mutation brusque à laquelle fut soumise une ou plusieurs femelles – certainement pas toutes les dizaines de milliers de la même génération – il reste cependant encore à interprêter: 1. la disparition de toutes les ♀♀ à ailes normales, 2. la résistance des mâles à ce processus régressif, et qui ne fut jamais transmis à ceux-ci par les éléments porteurs de l'hérédité.

Sélection naturelle – Peut-on admettre, contrairement à ce que nous voyons chaque année, parmi les millions de Papillons et autres Insectes que des ♀♀ ailées seraient moins aptes à la vie et en particulier à la dispersion de l'espèce que des corps non ailés, transportés comme des larves lentement par leurs pattes et privés de toute possibilité de s'envoler? La destruction des ♀♀ ailées serait donc celle des organismes les plus perfectionnés par rapport aux aptères. Il est difficile de concevoir que la possession d'ailes et la capacité de s'envoler seraient dans le „struggle for life" devenues une infériorité, nuisible à l'espèce. Et cela d'autant plus que la perte des ailes ne fut pas compensée par de nouvelles armes de défense.

Non-usage – Peut-on évoquer ce changement profond dans le comportement biologique des femelles par non-usage?

La perte des ailes n'a aucune valeur utilitaire pour la femelle, ce qui rend inintelligible que celles-ci, contrairement à son instinct de répandre l'espèce sur de vastes étendues ait renoncé à l'usage des ailes. Les objections déjà faites au sujet d'une éventuelle sélection naturelle sont aussi valables à la critique d'un non-usage hypothétique.

La perte des ailes ne pouvait être que nuisible, étant donné que la femelle n'arrive plus, en s'envolant à se soustraire à ses nombreux ennemis comme des Coléoptères, Fourmis, Araignées, Saurophidiens, Oiseaux et Insectivores comme les Musaraignes. Une seule exception est à noter: les Cheiroptères; vis-à-vis de ceux-ci la sédentarité de la ♀ est avantageuse pour la conservation de l'espèce.

Misère physiologique – Les expériences avec des chenilles de *Thaumatopoea pityocampa* Schiffm. élevées avec des aiguilles de Pinus maritimes Lam. desséchées montrent qu'une alimentation deficitaire *peut* amener à de

fortes réductions des ailes et *même produire des formes microptères.* Elles semblent aussi plaider en faveur de la thèse de l'existence d'un substratum physiologique intrinsèque propre aux sexes variables selon l'espèce et plus ou moins sensible à l'action d'agents extérieurs.

Les résultats de ces expériences élargissent le terrain de discussion sur l'apparition de femelles microptères dans l'Ordre des Lepidoptera.

INTERSPECIFIC CROSSES BETWEEN DROSOPHILA SPECIES LIVING ON DIFFERENT CONTINENTS

by

A. BUZZATI-TRAVERSO and R. SCOSSIROLI

Pavia, Italy

Crosses between species belonging to the genus *Drosophila* have been carried out extensively in the course of recent years, mostly by J.T.PATTERSON and his school (The Univ. of Texas Publications). The results are of great value in establishing relationships between species and races and in correlating the similarities with the present geografic distribution. The species involved in the successful crosses, which are about one hundred, are either cosmopolitan species or species living within a not too wide area, at the most a single Continent.

In order to establish the relationships between species living on different Continents it seemed of interest to check whether crossings were possible between any two species coming from far apart regions. The interest was prevalent especially for known species living on different Continents but belonging to the same Subgenus or to the same species group, in the sense used by STURTEVANT (STURTEVANT, 1942).

Experiments aimed at ascertaining such possibilities are being developed at the Department of Genetics of the University of Pavia (Italy), making use of the living material reared in the *Type Culture Collection of Drosophila Species*, there located, sponsored by the *International Union of Biological Sciences*.

The experiments have been started on species belonging to the *obscura* subgroup of the *obscura* group of the Subgenus *Sophophora*.

The *obscura* group has been subdivided by STURTEVANT (1942) into two subgroups, *obscura* and *affinis*; both of them being represented on the European as well as on the American Continent.

The *obscura* subgroup includes the three well known American species, *D. pseudoobscura* Frolowa, *D. persimilis* Dobzhansky and Epling and *D. miranda* Dobzhansky, which have been used by DOBZHANSKY and collaborators for their classic work on population genetics. On the American Continent a fourth species, *D. frolovae* Wheeler has been recently described as belonging to this group. In Europe the *obscura* subgroup is represented by six species: *D. alpina* Burla, *D. ambigua* Pomini, *D. bifasciata* Pomini, *D. obscuroides* Pomini, *D. subobscura* Collin and *D. tristis* Meigen. While the three above mentioned American species were known to give progeny when crossed (DOBZHANSKY 1935, DOBZHANSKY and TAN 1936), the five last mentioned European species proved not to be crossable with each other (BUZZATI-TRAVERSO, 1941). In the course of extensive tests with the available material it came out that *D. ambigua* females when crossed with *D. pseudo-*

obscura, *D. persimilis* or *D. miranda* males gave existence to a small number of larvae, some of which pupated but did not produce adult individuals.

All the strains which are reared in the *Type Culture Collection of Drosophila Species* have been used, both for *D. ambigua*, for which three strains are available, one Italian, one Swiss and one Austrian, and for the American species of which the following strains have been used: *D. pseudoobscura* Amecameca, *D. pseudoobscura* Aspen (Arrow Head gene arrangement), *D. pseudoobscura* Morelia (Tree line g.a.) *D. pseudoobscura* Oaxaca, *D. pseudoobscura* Pinion (Arrow Head g.a.), *D. pseudoobscura* Pinion (Chiricahua g.a.), *D. pseudoobscura* Pinion (Standard g.a.), *D. persimilis* Hope (Klamatt g.a.), *D. persimilis* Porcupine (Arrow Head g.a.), *D. persimilis* Sequoia (Standard g.a.), *D. miranda* Big Basin. It had been shown by the work of DOBZHANSKY and collaborators (DOBZHANSKY and TAN 1936, DOBZHANSKY and STURTEVANT 1938, DOBZHANSKY and QUEAL 1938, DOBZHANSKY 1944), that there are remarkable differences in the "gene arrangements", as revealed by the salivary gland chromosomes analysis, between the three American species and their geographical races. Such differences can be referred mostly to the "gene arrangement" of the third chromosome.

The crossings between the three European strains with the above mentioned American ones showed that one could recover different numbers of pupae from the same number of parental flies per colture-bottle, reared in the same conditions. Even though our data are not to be considered as final on this point, there seems to be a difference in respect to different "gene arrangements" as shown by the following table:

	Average number of pupae per culture-bottle		
	Strains of *D. ambigua*		
	Italian	Swiss	Austrian
D. persimilis Hope (Klamatt g.a.)	4.7	3.1	3.5
D. persimilis Sequoia (Standard g.a.)	5.3	8.0	6.8
D. pseudoobscura Pinion (Standard g.a.)	7.2	5.9	5.2
D. pseudoobscura Pinion (Chiricahua g.a.)	12.8	14.8	17.2

The percentage of hatching eggs layed by *D. ambigua* females crossed with males of the mentioned American species is very low. The following indicative data may give an idea of how low they can be:

D. ambigua × *D. persimilis*
Nr. eggs examined 18,181; nr. eggs harched 37 (0,20%)

D. ambigua × *D. pseudoobscura*
Nr. eggs examined 12,233; nr. eggs hatched 67 (0,54%).

Since a small number of ripe hybrid larvae can be secured, it has been possible to study the salivary gland chromosomes.

It should be mentioned that while the *D. persimilis* and *pseudoobscura* show in their mitotic metaphase plates one pair or large V-shaped chromosomes, three pairs of rod shaped chromosomes and one pair of dot shaped chromosomes, *D. ambigua* has four pairs of V- or J-shaped chromosomes and one pair of dots.

The number of chromosomes is therefore equal, being five, but their shape is remarkably different. Correspondingly the picture one obtains in the salivary gland chromosomes is very different: *pseudoobscura* and *persimilis* show five long strands and a very short one originating from the chromocentre, *P. ambigua* on the contrary shows eight strands shorter than the long ones of *pseudoobscura* and a very short one originating from the chromocentre.

The appearence of the salivary gland chromosomes of the hybrid is very peculiar indeed, in that there are thirteen long strands and two very small ones originating from a common chromocentre. It is possible to identify the five threads of the male parental species and the eight threads of the female parental species. No pairing has been observed so far between the chromosome elements of the two parental species. Such a possibility however cannot be excluded, owing to the relatively small number of hybrid larvae that have been studied so far.

Such results may have some interest because they show a certain degree of relationship between American and European species of the *obscura* subgroup. Such findings open a number of puzzling questions since the distribution of the American species is limited to the Western part of North America; the linkage ought to be looked for in the Eastern part of Asia, but no species belonging to this group have been described from that region.

This type of hybrid sterility is noteworthy because it brings about death of the hybrid zygotes at the larval or at the pupal stage. A similar condition had previously been found only in the hybrids between *D. arizonensis* Patterson and Wheeler and *D. buzzatii* Patterson and Wheeler; both species belong to a quite unrelated group, in fact to a different Subgenus, and have a similar chromosome configuration in number and shape.

Another example of relationship between species having a very different geographic distribution range, has been found in the Subgenus *Pholadoris*. Here it has been found that *D. nitens* Buzzati-Traverso, a European species, can be crossed with either *D. victoria* Sturtevant, an American species, or with *D. lebanonensis* Wheeler, an Asiatic species. Hybrids are being obtained in reciprocal crosses and only sterile adult females appear.

D. victoria and *D. lebanonensis* are perfectly interfertile with each other, and since they are morphologically alike, they could be considered as one species, and only the name *victoria* Sturtevant should be maintained.

Their salivary gland chromosomes have not been studied yet.

Similar tests on the relationships between *Drosophila* species living on different Continents are under way and it can be hoped that similar data may bring useful evidence as to the remote phylogeny of the Genus.

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DISCUSSION

Mr. **Handschin**: Ich weise hin auf die Pleiotropie, wonach ganz nahe liegende Arten leichter kreuzen als entfernte und auf meine Versuche mit *Spalangia* von Java, Australien und den Sundainseln (Rev. Suisse Zool).

SECTION IV

PHYSIOLOGY

ON THE TARSAL CHEMICAL SENSE, AND ITS SIGNIFICANCE AND DISTRIBUTION IN THE CLASS INSECTA

by

L. TIENSUU

Helsinki, Finland

Summary

It has been known for some time that the honey-bee, a few butterflies of the family Nymphalidae and some flies of the families Drosophilidae, Muscidae and Calliphoridae have a sense of taste, the site of which is the tarsus. Some experiments made last year have been the outcome of observations on several visitors of honey dew and flowers with open nectaries; – the behaviour of these insects gives an indication that they obviously find the food in part with the aid of the tarsi. The following results may be mentioned.

1. When a tarsus comes in contact with sugar, and the insect responds by extending the proboscis, it is still not able to localize the food without a tactile sensation.

2. The response occurs, commonly in a fraction of a second to both sweetened water and dry sugar. From this it must be concluded that the papillae on the end of the tarsal chemoreceptors secrete a little fluid, which in a moment dissolves some molecules from the solid sugar, and so makes its perception possible.

3. The species which have been shown to possess the tarsal chemical sense belong to the following families: a) Diptera: Tipulidae, Sciaridae, Culicidae, Syrphidae, Muscidae, Dexiidae and Tachinidae; b) Lepidoptera: Noctuidae; c) Trichoptera: Phryganeidae and Limnophilidae.

The tarsal chemical sense is probably common in these families, which include a great number of flower visitors and suckers of honey dew, extrafloral nectaries and birch sap. Their mouth-parts are adapted for taking very small food droplets. With the aid of the tarsal chemical sense they find even dry and invisible drops of honey dew and can utilize them.

DISCUSSION

Mr. **Lewis**: Dr TIENSUU referred to the terminal capsule on a tarsal receptor described by ELTRINGHAM for a species of *Pyrameis*. Such a structure is not found on the tarsal chemoreceptors of *Phormia terraenovae*, which I have recently studied. I have found small receptors, of the type usually taken to be chemoreceptive, on the tarsi of the tsetse fly, *Glossina palpalis*. A functional significance for tarsal chemoreceptors in this species cannot

easily be imagined, and I would like to ask Dr TIENSUU if he knows of any examples of tarsal chemoreception not obviously associated with the feeding habits of the species concerned.

Mr. **Tiensuu**: No, I have only studied flower haunting species.

STUDIES ON KRAUSS' ORGAN OF TMETHIS PULCHRIPENNIS ASIATICUS UVAROV (ACRIDIDAE, ORTHOPTERA)

by

A. SHULOV

Jerusalem, Israel

Introduction

The structure and function of the oblong, rugous plate on the second abdominal segment of all Trichnini (Acrididae, Orthoptera) have been the subject of some controversy.

It was first mentioned by STÅL (1873), then by GRABER (1875), and was described by KRAUSS in *Prionotropis hystrix* (1878) as a sound-producing organ. BRUNNER (1882) and PANTEL (1886) did not accept this view. UVAROV (1943) discussed the matter in full and coined the name "KRAUSS' organ" for this structure considered as an organ for the perception of air pressure.

At the suggestion of Dr. B.P.UVAROV I made observations on the structure and function of this organ in *Tmethis pulchripennis asiaticus* Uvarov.

Description

The KRAUSS' organ in adult *Tmethis pulchripennis asiaticus* Uvarov is an oblong plate situated on the ventro-lateral margin of the second abdominal tergite. It is diagonally placed with its fore end elevated dorsad, almost bordering on the tympanum. It is raised above the level of the tergite, and is covered with numerous tubercles some of which are arranged in rows. The second abdominal spiracle is situated at the ventral border of the plate. The boundaries of the KRAUSS' organ are clear-cut in adults and subadults, but are less conspicuous in the younger stages. The length of the KRAUSS' organ grows steadily from moult to moult at the same rate as hind femur.

There is a striking resemblance between the KRAUSS' organ and the triangular areas on the ventral border of the third, fourth and fifth segments. Similar areas have also been found in *Prionosthenus* sp. (Pamphaginae, Acrididae, Orthoptera).

The ventral part of KRAUSS' organ is elastic and may be readily indented. When pressure is released, this part springs back to its previous position. The dorsal and dorsocaudal side of KRAUSS' organ is thick with a stout chitinous rim. There is a soft membrane between the anterior border of the K.O. and the coxal cavity of the hind leg, as well as between the K.O. and the ventral border of the tergite. When the insect presses its hind legs toward the abdomen (during oviposition or before a jump) it is the KRAUSS' plate which absorbs the shock, because of its elevation above the level of the tergite. The importance of protecting the second abdominal spiracle is further stressed by the fact that the third to seventh abdominal spiracles are closed and do not respire.

Anatomy

Twenty *Tmethis pulchripennis* of various instars were dissected, and the structure of the organs adjoining the inner surface of the K.O. was studied.

A pair of large air sacks connected with tracheae lead to the second abdominal spiracle which is embedded in the K.O. The spiracle is provided with a short occlusor muscle and a long opening muscle. There are four peristigmatic glands. A thin branch of a nerve originating in the third thoracic ganglion was observed to terminate in the muscles of the dorsal border of the K.O. Other branches of the same nerve split in two, one portion entering the opening muscle of the second abdominal spiracle and the other innervating sterno-pleural muscles of the same segment.

The presence of KRAUSS' organ has led to certain changes in the number and direction of the muscles of the second abdominal segment. Comparison of the musculature of this segment with that of the third, fourth and fifth abdominal segments revealed that the induced changes are mainly associated with the smaller muscles of the tergo-pleuro-sternal border area, while no changes in the longitudinal sternal and dorsal muscles, or in the transverse tergo-sternal muscle were observed (5). The oblique tergo-sternal muscles (4), which are inserted in the ventral part of the third, fourth and fifth abdominal tergites, are connected to the hind dorsal margin of the K.O. in the second tergite. This muscle is completely covered by the above-mentioned tergo-sternal muscle (5). The sterno-pleural (2) muscle becomes elongated and is inserted in the ventral margin of the K.O. Two muscles, whose origins are not clear, are connected to the lateral margin of the second sternite and are inserted in the anterior border of the K.O. (9).

This muscular system apparently enables the K.O. to describe slight movements independently of those of the abdomen.

Histology

Six *Tmethis pulchripennis* (adults, subadults and hoppers) were dissected, and the KRAUSS' organ with the adjoining tissues were fixed in BOUIN's fluid. Sections of 6 and 8 μ were stained in EHRLICH-Eosin and in HEIDENHEIN-Eosin.

The K.O. is easily distinguished by the undulant shape of the cuticle and of the underlying hypodermis. The cuticle is thin in the ventral part of the plate, except around the spiracle and it grows progressively thicker towards the rim from its dorsal and dorso-caudal side bordering the organ, behind which the cuticle of the integument becomes progressively thinner in a dorsal direction.

The hypodermis is comparatively thick and is often conspicuously columnar, being especially high around the spiracle. No clear sensory differentiation was observed in the cuticle, although the fibres and cells of the peripheral nervous sensory system were seen in several sections.

Abundant fat body fills the spaces between the muscles, tracheas and air sacks.

Experiments on the function of KRAUSS' organ in Tmethis pulchripennis

Certain experiments were carried out on *Tmethis pulchripennis* grasshoppers whose K.O. had been damaged in order to compare their behaviour with that of normal controls. The responses of such grasshoppers to light and to low and high air pressure were studied.

Painting KRAUSS' organ with lac failed to impair its function. K.O. of about twenty grasshoppers (subadults and adults) were put out of action by cauterisation with a redhot needle. At first insects treated in this way quickly died, but later they lived for more than one month, i.e. about the time that normal grasshoppers remained alive in the laboratory and in the field.

Five continuous observations of from four to five hours each were carried out on the grasshoppers with both their KRAUSS' plates damaged as described above. These grasshoppers were maintained together with several normal ones in a spacious cage with a frosted 60 W. bulb illuminating one corner. The positions of all the grasshoppers were recorded. No difference in behaviour was observed with respect to crawling, eating or basking. Some of the treated grasshoppers courted and mated just as did the normal ones.

Pairs consisting of one treated and one normal adult *Tmethis pulchripennis* were put into 750 cc. Erlenmeyer flasks connected with a suction oil-pump. In each experiment the atmospheric pressure was reduced to one fourth normal for five to six minutes, and then restored to normal. The experiments were repeated 3 times with each pair of grasshoppers. Twelve grasshoppers were used in all. No difference whatever in the reaction of the grasshoppers was observed.

Similar observations were carried out on two groups of four male *Tmethis pulchripennis* grasshoppers, two of which had their KRAUSS' organ damaged as above. The insects were placed in a large exsiccator flask and air was pumped in by means of a hand air pump until the pressure gradually reached 1½ atmospheres. Each experiment continued for 10 minutes and was repeated 5 times. No differences in response of the normal and treated grasshoppers was detected.

Discussion of results

Sections and microscopic studies of the KRAUSS' organ showed that it has no particular sensorial differentiation. No nerves leading to its integument were observed. KRAUSS' organ was not demonstrated to play a rôle in the responses of these grasshoppers toward light and air pressure.

Grasshoppers with damaged K.O. did not differ from normal controls in eating, courting or mating.

Since the third to the seventh abdominal spiracles are closed and do not function, the remaining ones (and among them the second one embedded in the K.O.) gain in importance. The main respiratory movements consist of lateral contraction of the abdominal tergites and sternites instead of the common contraction of the entire abdomen along its longitudinal axis.

The rôle of the KRAUSS' organ seems to consist of protecting the second abdominal spiracle against the pressure of the hind femur upon the body.

Summary

The structure and function of the oblong, rugous plate (the so-called KRAUSS' organ) situated in the second abdominal segment of ***Tmethis pulchripennis asiaticus*** Uvarov has been studied.

It was suggested that this plate may possibly protect the second abdominal spiracle embedded in it against the pressure of the hind femur during respiration.

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DISCUSSION

Mr. **Chopard**: What is the case of KRAUSS' organ in the species of the genus *Lamarckiana* in which the male is fully alate and the female completely apterous?

Mr. **Shulov**: In both sexes the organ is perfectly developed.

LES PHENOMENES PARTICULIERS, QUI ACCOMPAGNENT LA FECONDATION CHEZ CERTAINS HEMIPTERES NABIDAE

par
Jacques CARAYON
Paris, France

De nombreuses espèces d'Hémiptères Nabidae, appartenant à la sous-famille des Prostemminae, présentent un mode particulier de fécondation, dont le caractère essentiel est le trajet indirect accompli dans l'organisme de la ♀ par les spermatozoïdes; ceux-ci, au lieu d'atteindre les ovocytes par la voie directe du tractus génital, passent par l'hémocoele et séjournent plus ou moins longtemps dans le sang.

Parmi les Insectes, de telles „fécondations par voie hémocoelienne" n'étaient jusqu'à présent connues – en dehors du cas très spécial des Strepsoptères – que chez les *Cimicidae*, dont le seul représentant étudié à cet égard est *Cimex lectularius* L., et chez les *Polyctenidae*, où H.R.HAGAN (1931) *) a seulement signalé la présence de spermatozoïdes dans la cavité générale des ♀♀.

Les fécondations hémocoeliennes des Nabidae Prostemminae résultent du fait suivant: lors de la copulation, le pénis du ♂, pourvu à son extrémité d'une forte épine, perfore la paroi de la chambre génitale et injecte les spermatozoïdes à l'extérieur *du tractus génital de la* ♀, le plus souvent dans l'hémocoele. Les phénomènes, qui se passent ensuite, très constants dans une même espèce, varient plus ou moins d'une espèce à l'autre; les modalités qu'ils présentent peuvent être, en gros, rattachées à 3 types principaux:

I. Chez plusieurs espèces d'*Alloeorhynchus* (notamment *A. flavipes* Fieb., *A. putoni* Kirk., *A. perminutus* Bergr.) les spermatozoïdes sont injectés directement dans l'hémocoele, et se répandent par les lacunes sanguines dans tout l'organisme de la ♀; on les v observe groupés en amas particulièrement abondants autour des troncs trachéens. A cette phase de *spermathémie*, qui peut atteindre 7 à 8 mois chez les individus hivernants, succède le *groupement périovarien* des spermatozoïdes, qui s'insinuent sous la tunique péritonéale entourant les ovarioles, puis pénètrent dans ces derniers à travers la paroi folliculaire. Ce stade ne précède que de peu la période de ponte.

Dans d'autres espèces du même genre (*A. plebejus* Pop., *A. elegans* Reut.), et chez les espèces étudiées du genre *Phorticus*, la spermathémie n'a jamais été constatée, et il semble que les spermatozoïdes déposés à la base des oviductes, comme chez les *Nabinae*, gagnent directement les ovarioles.

*) H.R.HAGAN, 1931. The embryogeny of the Polyctenid, *Hesperoctenes fumarius* Westwood, with reference to viviparity in insects. Journ. Morph. and Physiol., *51*, p. 1-92.

II. Chez les *Prostemma eva* (Kirk.), *sanguineum* (Rossi) et *bicolor* Ramb., les processus de fécondation, bien que présentant des différences secondaires, appartiennent sensiblement au même type. Lors de la copulation les spermatozoïdes sont, comme dans le cas précédent, injectés directement dans l'hémocoele; le plus souvent, ils se groupent ensuite en „balles" sphériques dispersées au milieu du tissu adipeux. La phase spermathèmique est courte, et quelques jours au plus après la fécondation on retrouve les balles spermatiques étroitement accolées à la paroi externe du pédicule des ovarioles.

Ce stade persiste durant tout l'hivernage chez *P. sanguineum* et *P. bicolor*, espèces paléarctiques où le passage des spermatozoïdes dans l'intérieur des ovarioles n'a pu encore être étudié.

Chez *P. eva*, d'Afrique tropicale, la masse tout d'abord externe des spermatozoïdes semble exercer une poussée continue contre la paroi des ovarioles en une zone déterminée; elle déprime cette paroi et la distend jusqu'à former un large sac saillant comme un battant de cloche dans la lumière du pédicule des ovarioles. Les spermatozoïdes, traversant l'épithélium très mince du sac, sont libérés petit à petit dans cette lumière, où ils rencontreront les ovocytes mûrs, qui descendent du vitellarium.

III. *Prostemma guttula* (Fabr.) présente un type de fécondation hémocoelienne, qui est le plus complexe rencontré jusqu'à présent. Les spermatozoïdes ne sont pas injectés directement dans l'hémocoele, mais dans une poche entièrement close, qui double le fond de la chambre génitale. La cavité de cette poche est remplie de sang contenant de nombreux hémocytes et des masses glandulaires sphériques, isolées les unes des autres; ces sphères glandulaires sont formées de cellules secrétrices particulières, qui proviennent elles-même de la différenciation d'hémocytes, ou du moins de cellules libres semblables à des hémocytes. La paroi de la poche est un „pseudo-épithélium", doublé du côté interne par une couche anhiste. L'ensemble constitue ce que j'appelle l'*organe spermalège* *). Celui-ci s'édifie chez les larves femelles, vers la fin du 5ème stade, à partir d'une lacune sanguine occupant la position du futur organe. La lacune est enclose par une couche d'adipocytes, tout d'abord semblables à ceux qui constituent le tissu adipeux environnant; puis ces adipocytes pariétaux perdent progressivement leurs enclaves, se divisent activement, formant le „pseudo-épithélium", qui est déjà nettement différencié au moment de la mue imaginale. Dans les jours qui suivent, ses cellules perdent tout caractère d'adipocytes, présentent du côté de la lacune un cytoplasme très dense fortement fuschinophile, et commencent à secréter la couche anhiste, faite d'une substance également fuschinophile, dont la nature chimique est encore inconnue.

Une à deux heures après que les spermatozoïdes ont été injectés dans cet organe, la paroi de ce dernier se lyse en un point, où se forme un orifice temporaire, par lequel un torrent de spermatozoïdes, mêlés à quelques sphères glandulaires, se déverse dans le sang.

*) de σπέρμα: semence, et λέγω: je recueille.

La phase spermathémique dure de 12 à 24 heures environ. Progressivement les spermatozoïdes se rassemblent en grand nombre autour des oviductes et de la base des ovarioles; ils s'insinuent entre les cellules de la tunique péritonéale, et finissent par former autour du pédicule de chaque ovariole un manchon épais; la paroi interne de ce „manchon spermatique" est constituée par l'épithélium du pédicule, doublé sur une partie de sa longueur par une tunique musculaire, tandis que sa paroi externe est la gaine péritonéale.

Ce stade persiste depuis la fin de l'été jusqu'au printemps de l'année suivante. Les orifices tant dans la paroi de la chambre génitale, que dans celle de l'organe spermalège, se referment quelques heures après la copulation, vraisemblablement par un processus de cicatrisation; une nouvelle copulation peut avoir lieu, et les mêmes phénomènes se reproduisent.

Un peu avant la période de ponte, les spermatozoïdes des „manchons spermatiques" traversent la paroi des ovarioles en une zone déterminée; cette zone est située dans la partie la plus distale du pédicule, juste en dessous de la masse cellulaire, qui obture le vitellarium; les cellules épithéliales forment en cet endroit un pli annulaire, et présentent un caractère secréteur, probablement en rapport avec le passage des spermatozoïdes, qui arrivent par la dans la lumière du pédicule de l'ovariole.

Il est remarquable qu'une formation aussi différenciée que l'organe spermalège de *Prostemma guttula* soit absente chez des espèces voisines, appartenant incontestablement au même genre, et présentant elles aussi une fécondation hémocoelienne.

Les femelles adultes de *Prostemma falkensteini* Stein possèdent contre une partie de leur chambre génitale une formation comparable à l'ébauche d'un organe spermalège, Il s'agit d'une vaste lacune sanguine enclose par une couche d'adipocytes normaux, et renfermant de nombreuses cellules libres, qui paraissent être des hémocytes d'un type particulier. Malheureusement, seules 2 femelles fixées de cette espèce tropicale ont pu être étudiées jusqu'ici; la spermathémie et le groupement périovarien des spermatozoïdes y ont été constatés, sans qu'ait pu être observé le rôle exact de cette formation interprétable par sa structure comme un organe spermalège peu différencié.

L'organe découvert par A.BERLESE chez *Cimex lectularius* L. existe chez les femelles de la plupart des Hémiptères *Cimicidae*; indépendant du tractus génital, il est accolé à une invagination tégumentaire, dont la position varie d'une espèce à l'autre, et qui est connue sous le nom d' „organe de RIBAGA". Tant par leur structure que par leur fonctionnement au cours de la fécondation, **l'organe de BERLESE et l'organe spermalège de P. guttula sont étroitement analogues**; leurs situations anatomiques diffèrent, mais ceci apparaît comme secondaire si l'on considère que l'un et l'autre de ces organes sont liés en fait à une *invagination tégumentaire fonctionnant comme cavité copulatrice.*

Les points de comparaison entre les fécondations hémocoeliennes des *Prostemminae* et celles des *Cimicidae* sont d'ailleurs nombreux. On trouve par exemple chez les *Ornithocoris*, Cimicidae sud-américains, des „manchons spermatiques" entourant la base des ovarioles comme chez les *Prostemma*.

Dans la superfamille des *Cimicoidea*, à laquelle appartiennent incontestablement les *Nabidae*, ceux-ci, les *Cimicidae* et les *Polyctenidae* ne sont sans doute pas les seuls à présenter des cas de fécondations par voie hémocoelienne. Ainsi il existe chez les femelles fécondées de certains Anthocoridae du genre *Cardiastethus* une phase spermathémique, et un groupement des spermatozoïdes en „manchons spermatiques", qui entourent les oviductes et la base des ovarioles. C'est en montant *dans la paroi* de ces derniers, comme cela se produit chez les *Cimicidae*, que les spermatozoïdes atteignent précocement les ovocytes.

Ainsi que le prouve l'étude des *Nabidae*, les fécondations par voie hémocoelienne peuvent se rencontrer seulement chez certains genres, voire certaines espèces d'un groupe dont les autres membres présentent un mode de fécondation normal. Les phénomènes, qui accompagnent de telles fécondations, posent au point de vue biologie générale de nombreux problèmes, dont le plus important, et sans doute aussi le plus complexe, est celui de leur déterminisme.

DISCUSSION

Mr. **Grassé**: Je prie Mr. CARAYON de préciser l'origine de l'„épithelium" de l'organe spermalège. S'agit-il bien d'adipocytes?

Mr. **Carayon**: La transformation progressive des adipocytes em cellules constituant la paroi de l'organe spermalège, a été suivie de bout en bout; il ne me paraît donc guère douteux qu'il s'agisse d'adipocytes, et non de cellules libres infiltrées entre ces derniers par exemple.

Mr. **Jucci**: Demando se ha applicato allo studio della secrezione di queste particolari cellule le reazioni tintoriali e microchimiche oggi usate per ricostruire il ciclo di trasformazione degli acidi nucleici; perchè questi fenomeni richiamano quanto io ho descritto per le cellule nutrici degli spermi nelle vescicole seminali dei re di Termiti ed io ho l'impressione che oltre ad attivazione possa esservi vera funzione di nutrizione degli spermi anche nel caso che l'Autore descrive.

Mr. **Carayon**: J'ignore encore s'il y a dans l'organisme des femelles des formations particulières assurant la nutrition des spermatozoïdes; aucune des différenciations histologiques qui paraissent liées à ces processus de fécondation ne me semblent jouer ce rôle.

STUDIES IN THE MODE OF ACTION OF INSECTICIDES
I. INJECTION EXPERIMENTS ON THE ROLE OF CHOLINESTERASE INHIBITION

by
H.S.HOPF and W.R.BOON
Bracknell, Great Britain

Introduction

To explain the mode of action of some of the modern synthetic insecticides, it has been claimed that the phosphoric esters act as inhibitors of cholinesterase.

The first symptoms observed in the toxic action of these types of poisons are connected with paralysis and nervous discoordination. It seemed, therefore, reasonable to suspect that these substances interfered with synaptic transmission by inhibiting cholinesterase, in particular so as the phosphorics are known to be powerful inhibitors of vertebrate cholinesterase.

The present work deals with direct injection experiments designed to accumulate evidence on the validity of this theory.

TOBIAS, KOLLROSS & SAVITT (1946) injected some cholinesters into *Periplaneta.* They found acetylcholin toxic at 7 - 10 g./kg., carbachol at 1 g./kg., and acetyl-β-methylcholine non-toxic at 20 g./kg.

CHADWICK & HILL (1947) injected cockroaches with DFP, hexaethyl-tetra-phosphate (HETP) and eserine and found that, on a molecular basis, HETP is most toxic. The three substances inhibit cholinesterase *in vitro* in nerve cord brei, but HETP less than the others. Injection with eserine produces reversible inhibition of cholinesterase, whereas DFP inhibition is always irreversible. With HETP results are variable, but show low inhibition compared with mortality. Although the authors are of the opinion that most of the toxic action of DFP can be accounted for by its anti-cholinesterase activity, no increase in mortality was observed when 100 μg. of acetylcholine or acetyl-β-methylcholine followed an injection of 5 μg. DFP.

ROEDER (1948) states that normal synaptic function in *Periplaneta* is dependent on the presence of a certain level of cholinesterase. *Yet acetylcholine and related substances had no effect on transmission through the ganglia and add little, if anything, to the action of the cholinesterase inhibitors* (HETP, DFP and eserine). Moreover, it was found that following the application of HETP, nerve cord contained 38μg./g. of acetylcholine, and following eserine 32 μg., by bioassay with frog nerves. Atropine, scopolamine, and curare were without effect. The author concludes from the synaptic change following destruction of the enzyme that a synaptic mediator substance persists, though he stresses that there is no evidence that the synaptic mediator is acetylcholine.

As an explanation of these phenomena he postulated either that acetylcholine, atropine, etc. are unable to penetrate to the synapses while cholinesterase inhibitors do, or that the synaptic transmission is not affected by acetylcholine.

METCALF & MARSH (1949) found that bee brain can break down acetylcholine and tested the inhibition of the esterase by 32 organic phosphorus compounds which were at the same time tested as insecticides against flies and bees. Some of the compounds, notably Parathion and TEPP, had a strong cholinesterase inhibitory action, and, on the whole, there was good correlation between this inhibitory action and toxicity to insects. Atropine had no effect on injected cockroaches.

DRESDEN (1949) in experiments co-incidental to a study of the physiological action of DDT, injected cockroaches with tubocurarine but found no effect, although up to 300 µg. were injected.

KRIJGSMAN, DRESDEN & BERGER (1950) studied isolated preparations of the cockroach heart. The insect heart is neurogenic, that is to say, acetylcholine does not inhibit it in low concentrations, but stimulates it in high concentrations (Nicotine-action). Both TEPP and acetylcholine were shown to have such an effect, and the heart could be sensitised to acetylcholine by TEPP concentrations too weak to have an effect themselves.

LORD & POTTER (1950) were unable to demonstrate an enzyme hydrolysing acetylcholine in breis of *Tribolium* and *Tenebrio*. These preparations did, however, hydrolyse o-nitrophenyl acetate and ethyl butyrate, and the hydrolysis could be inhibited by TEPP. They make the point that, since TEPP is an ovicide, acting on stages before the development of the nervous system, its action is likely to be unconnected with anti-cholinesterase activity.

The most important points from this review appear to be :

DFP, TEPP(HETP) and eserine are undoubtedly cholinesterase inhibitors and can act as such on insect nerve tissue, which has the ability to break down cholinesters, and can produce a substance that is like acetylcholine in its action on vertebrate nerve; but acetylcholine itself appears to have no action on the insect, nor is there any evidence that it plays any part in synaptic transmission. The only established physiological action by acetylcholine alone on the insect is a nicotine action on the heart.

In experiments, here reported, we have endeavoured to study the effect of cholinesters on the African migratory locust – *Locusta migratoria migratoriodes* R. & F. – by direct injection into the body cavity of the insect. Substances that are known inhibitors of mammalian cholinesterases were also studied, and so was their interaction with acetylcholine. They were compared with TEPP, which is a very powerful insecticide, whose mammalian anticholinesterase activity is well known. In the mammal, atropine is the usual antidote against poisoning by cholinesterase inhibitors, and we have investigated its effect in the insect. Finally, we have included in our work two substances which have a powerful effect on the mammalian nervous system, d-tubocurarine and adrenaline.

Methods

Young virgin adults of *Locusta migratoria migratoriodes*, bred at a temperature on app. 30^{0} C on a diet of fresh grass or cereal shoots, were used. The sex ratio in all experiments was 50: 50.

Injection was carried out with an 'Agla' micrometer syringe, using a 26 B.W.G. exploring needle. For injection the locust was held ventral side upward, and the needle of the syringe, which was fixed on a retort stand, passed forward tangentially underneath the second abdominal tergite until its tip would be in the middle of the thorax, between the body wall and the alimentary canal. The insertion was made slightly laterally to avoid injuring the nerve cord. Mortality counts were made after 24 hours.

Results are expressed as µg. per locust. This corresponds approximately to mg/kg, the average weight of locusts of equal sex ratio being about 1 g.

Results

(a) *Toxicity of substances applied alone*

Of the four cholinesters tested none seemed to have any effect on the locust. They did not produce any significant mortality, nor were there any symptoms, temporary or permanent, to be observed on the treated insects.

Prostigmine bromide was also non-toxic and produced no symptoms. Eserine (physostigmine), however, had a clear toxic activity and produced paralytic symptoms immediately after injection. In all cases where death did not occur, complete recovery from these symptoms took place within a few hours.

Atropine gave a kill of 35% at 800 µg, but was non-toxic at all lower dosages tested. No symptoms of any kind were observed.

d-Tubocurarine and adrenaline were non-toxic and produced no symptoms. The two phosphoric insecticides were much more toxic than any other substance tested, and both caused immediate paralysis. In the case of TEPP, complete recovery occurred invariably within a few hours in all cases which did not lead to death, while recovery from parathion poisoning was slower but this is probably due to the greater chemical stability of the latter substance.

(b) *Antagonistic action of atropine*

In these experiments, injections of either TEPP or eserine were followed by injections of atropine. In one case the order of injection was reversed, and in one experiment the TEPP was applied topically to the head instead of being injected.

In comparing mortalities produced by injection of the lethal substances with and without atropine it was seen that this variation is completely random, and that no correlation exists between mortality and the injection of atropine.

There is no evidence that d-tubocurarine has any enhancing effect on the toxicity of eserine and TEPP.

(c) *The effect of acetylcholine chloride on TEPP-treated insects*

In the first group of experiments, acetylcholine was injected immediately following injection of TEPP. Although only a few seconds elapsed between the two injections, the locusts mostly showed the usual symptoms of TEPP when the second injection took place. However, the presence or absence of acetylcholine chloride did not affect the rate of reviving in any way, nor did it aggravate the symptoms.

In one experiment the cholinester was injected after time intervals varying between 0 and 60 minutes, but there is no correlation between this time interval and mortality.

Discussion

Three theories occur as a possible explanation of all these phenomena:

1. The insect cholinesterase, although inhibited by extremely small quantities of TEPP, is powerful enough to decompose the large amounts of cholinesters injected instantaneously.

2. The physiological action of acetylcholine is strictly localised and injected doses of the cholinesters, atropine, tubocurarine and physostigmine cannot reach the site of action (synapses) even though the integument has been bypassed, whereas TEPP and eserine can.

3. Acetylcholine and the other esters do not have a physiological effect on the insect (in particular as synaptic mediators) at all, and therefore the insecticidal action of TEPP etc. cannot be one of cholinesterase inhibition. (The last two of these theories are already mentioned by ROEDER (loc. cit.).)

The first of these theories, we think, should be dismissed. There are never any symptoms to be observed on injection of cholinesters, while injection of TEPP and eserine produce immediate paralysis and nervous discoordination. If these symptoms are due to an immediate accumulation of acetylcholine, some similar symptoms should at least temporarily be observed by injection of large amounts of this substance.

The second theory, which concerns that of differences of penetrative ability between the active and inactive substances, has some points in its support. Although the integuments cannot act as a barrier, injection into the abdominal cavity does not mean immediate access to the synapses. These are surrounded by an epineurium, about the nature of which little is known. Nevertheless, there seems to be no obvious reason supporting these assumptions from the point of view of purely physical properties. Admittedly, the lipoid solubility of the cholinesters, atropine and tubocurarine appears to be very low, and if a lipoid layer has to be passed to reach the site of action, this would be an impediment. But so is the lipoid solubility of eserine, and, although this substance is less toxic in insects than in vertebrates, it is yet very much more toxic than the cholinesters.

Two observations in the literature reviewed give support to the anticholinesterase activity of insecticides, which, if proved, would leave diff-

erences in penetration power as the only possible explanation. First, there are the observations by TOBIAS et al. (loc. cit.) and ROEDER (loc. cit.) on the accumulation of acetylcholine in the nerve cord of the cockroach after treatment with insecticides. But all these authors definitely established the presence of a substance which acts like acetylcholine on the rectus abdominis of the frog. There is no evidence to show that the substance in question really was a choline ester. Secondly there is the good correlation obtained by METCALF & MARSH (loc. cit.) for the toxicity of their phosphorus compounds and their ability to inhibit the acetylcholinesterase of bee brain. Against this, however, must be quoted that CHADWICK & HILL (loc. cit.) found HETP more toxic than DFP or eserine by injection, and less active as an *in vitro* inhibitor of cholinesterase. It may also be that the cholinesterase of bee brain plays no role in the synaptic transmission in that quality – in other words that an enzyme fulfilling a function on a different substrate also happens to hydrolyse cholinesters.

The main support of the third theory – that cholinesters do not act as synaptic mediators in insects – derives from the fact that no direct influence of cholinesters has been noted. The sole exception is the observation by KRIJGSMAN et al. (loc. cit.) that acetylcholine has a stimulating effect on the heart. This effect alone would certainly be of little importance in insecticidal action. The insect heart does not have the important function of the vertebrate heart, it is an open system for the general, and not very efficient, distribution of body fluids with no respiratory function. It could be completely stopped long enough to allow for the excretion, let alone enzymatic hydrolysis, of the acetylcholine to take place, without killing the insect.

Adoption of the third theory would mean the postulation of a synaptic mediator which acts similarly to acetylcholine on the nerve of the frog and is decomposed by an enzyme also capable of hydrolysing acetylcholine and of being inhibited by substances which inhibit cholinesterases. It must be a substance less physiologically specialised than acetylcholine, since it can produce actions in vertebrates similar to the latter compound, but not vice versa. The performance of the same physiological function by two different methods in two groups of organisms is not unusual, even where the two groups are much more closely related than insects and vertebrates.

We conclude, therefore, that it is doubtful whether insecticides do act as cholinesterase inhibitors. The enzyme concerned and inhibited by the phosphoric insecticides is more likely to be a general esterase, a view which receives support by the results of LORD & POTTER (loc. cit.). It is hoped that an *in vitro* study of the activity and inhibition of insecticides will form the subject of a further communication.

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DISCUSSION

Mr. **Stegwee**: Since NACHMANSOHN proved insect nerves to be impermeable to acetylcholine, could there possibly be not a physiological but only an anatomical difference between insect and mammalian nerves?

Mr. **Hopf**: I do by no means rule out the possibility, but I do think it the less likely explanation, in view of the negative results with so many substances, and particularly in view of the failure of atropine to abolish the effects of TEPP. The main purpose of this paper is to show that the choline ester theory must not be taken for granted on mammalian analogy only.

EFFETS LETHAUX SELECTIFS D'UNE SUBTANCE ACETYL-CHOLINIQUE SUR QUELQUES ESPECES D'INSECTES

par
Luigia GRANDORI
Milano, Italia

Depuis deux années, dans l'Institut d'Entomologie agricole de l'Université de Milan, on a entrepris l'étude des effets physiologiques causés par l'administration à des espèces d'insectes appartenants à des ordres différents, de substances qui appartiennent aux médicaments du système nerveux des mammifères.

Les expériences préliminaires nous ont porté à borner notre étude aux effets des médicaments expliquant une forte activité pharmacodynamique sur le système nerveux végétatif des mammifères, et, particulièrement, sur le système parasympathique, parce que l'appareil locomoteur des espèces d'insectes expérimentés, larves et images, s'est demontré particulièrement sensible aux substances parasympatholytiques, parasympathomimétiques et anticholinestérasiques.

Jusqu'ici la substance parasympatholytique expérimentée a été l'atropine, dont les effets remarquables sont l'objet d'une communication de notre collaborateur, Mr le Docteur REALI, qui l'a essayé sur les chenilles de *Galleria mellonella* L.

Après des épreuves comparatives avec le curare, nous avons trouvé que pour obtenir le même effet toxique qu'avec l'atropine, il faut employer des doses de curare dix fois supérieurs: par conséquant on peut penser que pour la stimulation du muscle volontaire de *Galleria mellonella* il faut atteindre un seuil élévé du médiateur chimique.

Les substances anticholynestérasiques expérimentées ont été la physostigmine ou ésérine et la prostigmine Roche.

Les substances acétylcholiniques expérimentées ont été le chlorure de acétylcholine et le chlorure de carbaminoylcholine Merck.

A cause de son action parfois parasympathomimétique et parfois curarisante sur les mammifères, nous avons aussi expérimenté le bromure de tétraméthylammonium, c'est à dire le sel d'une amine quaternaire simple.

Les espèces d'insectes auxquelles nous avons administré ces différentes substances ont été:
les images de *Musca domestica* L. résistantes, ou non, au D.D.T. et au O.K.T., les larves de *Culex pipiens* L., les chenilles et les images de *Bombyx mori* L., les images de *Cydia molesta* Busck, les images de *Leptinotarsa decemlineata* Say et de *Melasoma aeneum* L., les larves et les images d'*Eriosoma lanigerum* Hausm., les larves et les images de *Myzodes persicae* Sulzer.

Les essais ont été faits par irroration, par injection et par contact.

Comme on devait s'y attendre, la physostigmine ou ésérine cause dans les insectes les mêmes effets qu'elle cause dans les mammifères, avec son pouvoir générique inhibiteur des cholinestérases, et par suite avec son action particulière sur les muscles de la locomotion et des appareils de la digestion et de la reproduction.

La prostigmine dans nos essais a démontré un pouvoir toxique par contact sur les mouches résistentes, ou non, au D.D.T. et au O.K.T., qui se posent sur un verre qui a été irroré auparavant avec une solution au 2,5 ‰ de prostigmine en l'eau, en raison de 0,3 g par m^2. Par un contact de 25' les mouches viennent à mourir en quelques heures.

Par un contact de quelques heures avec les mêmes verres les images de *Melasoma aeneum*, sont tuées au 100/100 dans 12 heures. Aussi les images et les larves de *Leptinotarsa decemlineata* par un contact de plusieurs heures sont amenées à la mort, en 48 heures les larves, en 90 heures les images. Mais le fait remarquable c'est que les effets causés par contact par cette substance anticholinestérasique n'est nullement semblable aux effets causés par l'ésérine, puisque, au contraire de l'ésérine, la prostigmine démontre avoir dans les insectes expérimentés par contact une action paralysante.

Il faut remarquer que les images et les larves de *Leptinotarsa* sont peu sensibles à la prostigmine administrée par injection: à la concentration 2,5‰ elles ne manifestent pas des effets ésériniques et les individus qui ont subi le traitement survivent longtemps. Aussi faut-il remarquer que la physostigmine produit, à la concentration de 1‰ administrée par injection, les effets typiques de l'ésérine avec des mouvements cloniques des pattes, des vomissements, des défécations et des pontes spasmodiques jusqu'à la mort des individus.

A la concentration du 2,5 ‰ de la même substance la mort des images de *Leptinotarsa* est presque immédiate. Par contre la prostigmine administrée par injection produit dans les mouches les mêmes effets que l'ésérine, c'est à dire des contractions cloniques des ailes et des pattes, des protractions spasmodiques de la trompe et de la tarière. Ces effets sont les mêmes que produit la carbaminoylcholine. Mais par contre la prostigmine administrée aux mouches par contact produit des effets paralysants sur les muscles de la locomotion et cause la rétraction de la trompe et de la tarière.

Il faut pourtant admettre qu'avec l'administration de la prostigmine par contact, les effecteurs de la conduction nerveuse ne sont pas intéressés, et que cette substance dans ce cas agit par un mécanisme inconnu presque exclusivement sur les voies nerveuses afférentes et sur les centres nerveux.

Et encore il faut remarquer que lorsqu'on injecte la prostigmine aux mouches, les contractions spasmodiques, du type ésérinique, sont interrompues par des périodes de paralyse presqu'absolue.

Dans les chenilles de *Galleria mellonella*, injectées par prostigmine au 5/10.000, on remarque d'abord l'action excitante, tandis qu'ensuite les deux actions, celle excitante et celle paralysante, s'alternent, et les périodes de paralysie deviennent toujours plus longues.

Le chlorure de tétraméthylammonium s'est démontré actif par injection et pas par contact sur la *Musca domestica*, résistante, ou non, au D.D.T. et au O.K.T., qu'il a tuée en 3 heures par une solution au 5‰. La solution à 1‰ a tué les larves de *Culex pipiens* en 12 heures. Une solution à l' 1% s'est démontrée active par injection sur les chenilles de *Galleria mellonella*. Les effets dans les muscles de la locomotion de ces animaux sont du type ésérinique.

Le chlorure d'acétylcholine injecté dans les chenilles de *Galleria mellonella* et de *Bombyx mori*, dans les mouches, dans les images de *Leptinotarsa* n'a jamais causé des effets excitants sur les muscles locomoteurs des insectes expérimentés. Par contre le chlorure de carbaminoylcholine s'est révélé actif par injection ou par contact sur la *Musca domestica*, résistante, ou non, au D.D.T. et au O.K.T., avec des effets sur les muscles locomoteurs très semblables aux effets causés par l'ésérine, c'est à dire, mouvements spasmodiques des ailes et des pattes et protraction de la trompe et de la tarière. La dose 50% toxique est pour les mouches environ d' 1 gamma.

L'*Eriosoma lanigerum* est tué au contact avec une surface de verre auparavant irrorée avec une solution dans l'eau de carbaminoylcholine. L'irroration d'un petit arbre de pêcher très infesté par *Myzodes persicae* avec une solution au 5% de chlorure de carbaminoylcholine a tué presque tout de suite les Aphides avec des effets ésériniques.

Les papillons de *Cydia molesta*, irrorés avec une solution à l' 1% ont été tués en 12 heures. Les larves de *Culex pipiens* ont été tuées en 60 heures par une solution à l' 1‰ de carbaminoylcholine.

Mais par contre la même substance n'a causé ni effets ésériniques, ni effets toxiques d'autre nature dans les images de *Leptinotarsa decemlineata* et de *Calandra granaria*. En particulier, l'injection d'une solution au 10% de chlorure de carbaminoylcholine dans les individus de *Leptinotarsa decemlineata* en raison de gr. 6,2 par kilo du poids du corps, cause des effets fort transitoires, jamais ésériniques, avec une survivance du 90% des individus.

Action résiduelle. Le chlorure de carbaminoylcholine a demontré une action résiduelle remarquable. Au contact d'une surface de verre irrorée 35 jours avant avec une solution de carbaminoylcholine à l' 1% en raison de 0.75 g par m^2, les mouches ont été tuées en 24 heures.

Au contact d'une surface de verre irrorée 40 jours avant avec une solution en l'eau de chlorure de carbaminoylcholine, en raison de gr. 7 pour m^2. Les mouches ont été tuées après 2 heures. Au contact avec la même surface, ... jours après l'irroration, les individus de *Melasoma aeneum* ont été tués dans 12 heures.

Nous avons de bonnes raisons pour admettre qu'aussi la prostigmine doit expliquer une action résiduelle notable.

Nos expériments nous ont amenés à conclure que la prostigmine manifeste deux actions: paralysante et ésérinique et que seulement l'action paralysante se manifeste sur *Leptinotarsa*. L'action par contact sur *Musca domestica* est paralysante; l'action par injection sur *Musca domestica* et sur *Galleria mellonella* fait les deux effets paralysant et excitant. On peut penser que l'une des actions n'est pas compatible avec l'autre, mais il est notoire que dans les mammifères les amines quaternaires nicotiniques, les poisons curarisants, les esthers de la choline, l'ésérine même, peuvent manifester, en particulier lorsqu'on fait varier les voies d'introduction, tantôt des effets convulsivants, tantôt una paralysie des centres respiratoires, que l'on interprète comme des réactions de substitution et de blocage de l'acétylcholine centrale.

Si l'on compare les résultats obtenus par le chlorure de carbaminoylcholine dans la *Leptinotarsa* avec ceux obtenus dans les autres espèces d'insectes on arrive à conclure que la *Leptinotarsa* doit posséder une cholinestérase spécifique capable d'hydrolyser bien vite la carbaminoylcholine.

Il est évident que les mammifères, les *Melasoma*, les mouches, les larves de moustiques ne produisent pas ce ferment spécifique.

Il est bien connu que le chlorure de carbaminoylcholine est une substance parasympathomimétique très stable, et qu'elle n'est pas hydrolysée par les cholinestérases des mammifères. Les effets de cette substance dans ces animaux ne sont aucunement potentialisés par l'administration d'ésérine; son action est muscarinique et nicotinique. Cette dernière est plus intense que celle produite par l'acétylcholine.

Dans les insectes sensibles à la carbaminoylcholine l'action acétylcholinique de cette substance est aussi très puissante par contact. Il faut bien remarquer qu'elle est très soluble dans l'eau et qu'elle ne l'est pas dans les lipides.

EINE METHODE ZUR UNTERSUCHUNG DER DIE NÄHRPFLANZENWAHL REGULIERENDEN STIMULI BEI ZIKADEN

von
Pekka NUORTEVA
Helsinki, Finnland

Eine Spezialisierung auf bestimmte Nahrungspflanzen ist für die Zikaden, wie für die phytophagen Insekten überhaupt, recht kennzeichnend. Die Zikaden suchen ihre spezifischen Nahrungspflanzen mit Hilfe ihres Geschmacksinns auf. Der Stimulus, der dem Tier die geeignete Nahrungspflanze verrät, muss also irgendeine Eigenschaft der Pflanzensäfte sein.

Die Frage nach der Beschaffenheit dieses Stimulus ist vom Standpunkt des theoretischen Verständnisses der Phytophagieverhältnisse sicher nicht wenig interessant. Eine Kenntnis desselben würde vielleicht auch zu einer Beschleunigung und Effektivisierung der auf die Erzielung resistenter Zuchtprodukte unserer Kulturpflanzen gerichteten Veredlungsarbeit beitragen können, indem man dieselbe auf diese Weise eines konkretischen Ziels bewusst macht.

Die zur Klärung jenes Stimulus durchgeführten Saftanalysen haben nur grobe Resultate liefern können (CARTER 1927, 1930). Da die meisten Zikaden ihre Nahrung aus den Siebröhren der Pflanzen saugen, müssten die Analysen eben den Siebröhreninhalt betreffen. Dies gestaltet sich aber in technischer Hinsicht überaus schwierig.

Man kann sich der Frage jedoch auch auf Umwegen nähern. Man stellt eine Reihe von verschiedenen künstlichen Nährlösungen her und studiert dann das Verhalten der Zikaden zu denselben. Ich habe zu diesem Zweck eine Vorrichtung konstruiert, die hier kurz beschrieben werden möge. Ihr Bau erhellt am besten aus der hier beigefügten Querschnittsfigur (Abb. 1).

Es handelt sich um ein Terrarium, dessen Bodenfläche in ihrer Gänze von drei nebeneinandergestellten Trögen eingenommen ist. Jeder Trog ist gesondert mit einem Netztuch bedeckt. Die Tröge können mittels einer Injektionsnadel durch das Netztuch hindurch mit der gewünschten Lösung gefüllt werden. Die Versuchstiere werden auf das Tuch gelegt und saugen die ihnen dargebotene Nährlösung durch denselben auf.

Die Versuche mit der hier beschriebenen Vorrichtung werden so ausgeführt, dass den Versuchstieren Gelegenheit gegeben wird, zwischen physikalisch oder chemisch verschiedenen Versuchslösungen zu wählen. Die in das Terrarium eingelassenen Tiere halten sich grösstenteils am Dach oder an den Wänden des Terrariums auf und begeben sich zwischendurch hinab auf das Netztuch um Nahrung zu saugen. Sagt die dem Insekt zu Gebote stehende Flüssigkeit ihm nicht zu, so zieht es seinen Saugrüssel sofort aus der Lösung zurück und begibt sich zu den anderen Flüssigkeiten. Wird dagegen die Lösung gern vom Tier genossen, so kann man es ununterbrochen

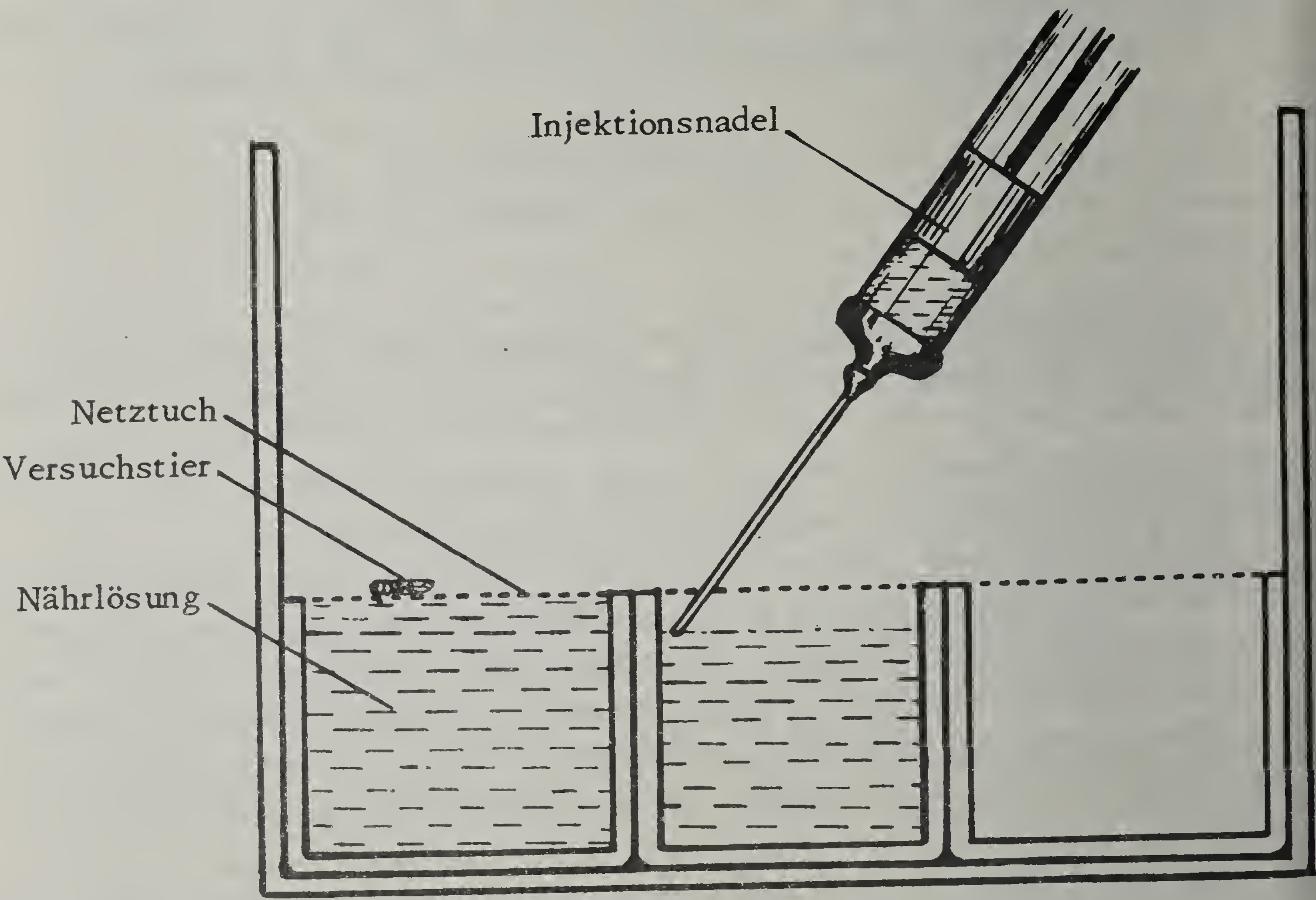

Abb. 1. Das angewandte Versuchsterrarium. Erklärung im Text.

stundenlang daran saugen sehen. Bei den Versuchen bin ich so vorgegangen, dass ich in Zeitabständen von 15 Minuten die an den Flüssigkeiten saugenden Tiere gezählt habe und dann als Versuchsergebnis die Summe sämtlicher während der Versuchszeit ausgeführten Zählungen habe gelten lassen.

Schliesslich in Form von Diagrammen noch kurz einige orientierende Ergebnisse, die ich bei meinen Versuchen mit der neuen Vorrichtung erzielt habe (Abb. 2).

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DISCUSSION

Mr. **Kennedy**: Have you any suggestion as to why the mesophyll-feeding species show a preference for sugar, while the phloem-feeders do not?

Mr. **Nuorteva**: Since the mesophyll-feeders are feeding on the photosynthetic tissues themselves where sugar will necessarily be encountered, that may be why they prefer, or at least tolerate, sugar in the solutions.

Mr. **Kennedy**: Have you tried the effect of raising the hydrostatic pressure of the food solution, above one atmosphere, on the willingness to feed or the rate of feeding of the insects?

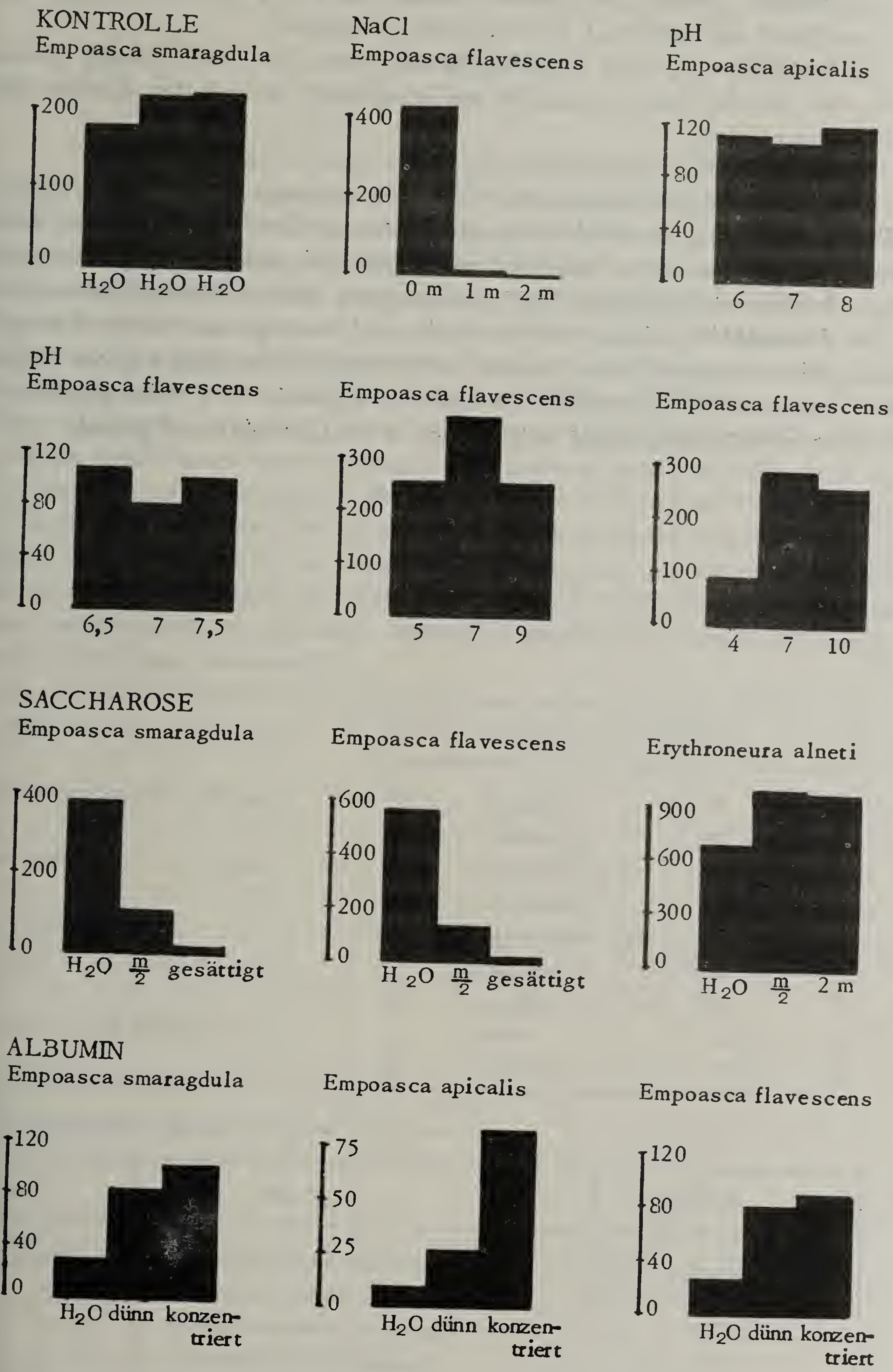

Abb. 2. Diagramme über einige orientierende Resultate mit der neuen Vorrichtung.

Mr. **Nuorteva**: No.

Mr. **Kuenen**: Gehen die Tiere leicht auf das Tuch, ohne Schwierigkeiten zu empfinden und sich doch leicht nähren zu können?

Mr. **Nuorteva**: Ja, ohne Schwierigkeiten, wenn die Tiere hungrig geworden sind. Mit den Larven ist es etwas schwieriger und mit den Aphiden geht es überhaupt nicht.

Mr. **Hartzell**: Were both larvae and adulti used in the experiments?

Mr. **Nuorteva**: Die Experimente habe ich meistens mit Imagines verrichtet, aber ich habe auch Versuche mit Larven gemacht und dieselben Reaktionen beobachtet. Alle dargestellten Ergebnisse sind mit Imagines erzielt und ich habe auch gefunden dass die imagines bessere Versuchstiere sind.

Mr. **Fraenkel**: It seems that your method of feeding could be used to great advantage to compare the chemical composition of the food and the "honey dew" produced by the insects. It would be important if it were possible to feed the cicadas for periods long enough to obtain significant growth.

THE NUTRITIONAL REQUIREMENTS OF INSECTS FOR KNOWN AND UNKNOWN VITAMINS

by
G. FRAENKEL
Urbana (Ill.), U.S.A.

Less than 12 years ago only about 3 of the B vitamins had been discovered. Two of these, thiamin (aneurin, B_1) and riboflavin (B_2) had been shown to be required by an insect *(Drosophila)*. Up to now at least ten numbers of the vitamin B-complex have been isolated and chemically identified, and insects have been shown to require at least 8 of them. I shall give a brief account of the results which have been obtained in my laboratory during the past 10 years from 1941 to 1948 at the Imperial College of Science and Technology, University of London, and since 1948 at the University of Illinois.

All our experiments were performed with insects which normally grow on dried food and stored products. The advantage in using insects of this type lies in the fact that they develop on a food which is air-dry and therefore not subject to deterioration by the action of microorganisms. In the course of the work an artificial ("synthetic") diet was developed which, in some case with minor modifications or additions, sustained growth of a variety of insect species. This diet consisted of

		Vitamins (µ g./g. diet)	
casein	20 parts	thiamin	25
glucose or starch	80 parts	riboflavin	12
cholesterol	1 part	nicotinic acid	50
McCollum's Salt mixture	2 parts	pyridoxin	12
water (at 70% R.H.)	10 parts	pantothenic acid	25
		choline	500
		inositol	250
		biotin	0.25
		folic acid	0.5

The following insect species were used:

Order	Species	Reference
Coleoptera	*Tribolium confusum* Duv.	3, 4, 5, 10, 11, 15
	Tenebrio molitor L.	10, 12, 13, 16. 17, 19
	Palorus ratzeburgi Wisman	18,
	Lasioderma serricorne F.	4, 5, 6, 14
	Stegobium (Sitodrepa) paniceum L.	4, 5, 6, 14
	Orycaephilus (Silvanus) surinamensis	4, 5
	Dermestes vulpinus L.	1, 2

Order	Species	Reference
Lepidoptera	*Ephestia kueniella* Fell.	4, 8, 9, 10
	Ephestia elutella Hb.	8, 9
	Ephestia cautella Walk.	8, 9
	Plodia interpunctella Hb.	8, 9
	Tineola bisselliella Hum.	7

Table 1. – Development of *Dermestes vulpinus* on an artificial diet, which contains the vitamins listed above, and on diets which are lacking in one single vitamin. At 30° C and 70% R.H. (unpublished data)

Diet	After 20 Days		Pupation			After 47 Days	
	No. Larvae	Av. Wt. Larvae	No. Pupae	Av.Wt. Pupae	Av.No.Days for Pupation	No. Larvae	Av.W Larva
		mg.		mg.			mg.
All Vitamins (insol. yeast)	19	41.0	19	36.9	23.2	–	–
All Vitamins (biotin)	18	39.7	16	34.3	23.9	–	–
Same + 1% yeast	17	36.4	15	36.0	22.8	–	–
Same + 5% yeast	19	36.1	15	36.9	23.2	–	–
No B_1 1)	10	5.8	10	27.2	39	–	–
No riboflavin	19	3.6	–	–	–	14	4.
No nicotinic acid	16	1.9	–	–	–	2	1
No pyridoxin	19	3.7	–	–	–	15	7
No pantothenic acid	6	2.5	–	–	–	–	–
No choline	20	29.3	19	28.6	27.2	–	–
No inositol	19	36.2	19	31.3	22.6	–	–
No folic acid	19	7.4	1	19.0	38.0	14	1[illegible]
No biotin	20	13.3	11	22.4	35.0	5	2[illegible]
+ PABA	15	45.0	15	37.3	24.4	–	–
+ B_T	17	40.4	16	38.4	24.5	–	–

1) only 10 larvae in experiment

As an example of the effects of the vitamins of the B-complex on larva development, the results of an experiment with *Dermestes vulpinus* are show

in Table 1. It can be seen that all the vitamins listed above are required for normal growth, with the exception of inositol. Paraaminobenzoic acid (PABA) was also not required. In the presence of all the vitamins listed, growth was as good as when the diet contained yeast. Biotin fully replaced the insoluble yeast fraction. No growth took place in the absence of either riboflavin, nicotinic acid, pyridoxin, pantothenic acid, or folic acid (pteroylglutamic acid). Growth was slow in the absence of thiamin, choline or biotin; most larvae pupated after some delay but the pupae were small.

The vitamin requirements were essentially the same for the other insect species studied except for the larvae of *Lasioderma, Stegobium* and *Silvanus* which grew well in the absence of some of the vitamins that were of importance for the other species. It was shown that, for *Lasioderma* and *Stegobium,* intracellular symbiontic yeasts provided the missing vitamins (6, 14).

The larvae of the mealworm, *Tenebrio molitor,* failed to grow on the diet listed above. At first it was found that *Tenebrio* required, in addition to the known B-vitamins some substance which was contained in a yeast or liver extract, and which we provisionally named B_T (12). B_T was finally isolated and identified as carnitine, a betain which was known to occur in meat extracts (16, 17, 19).

Insects therefore require most, if not all, the vitamins of the B-complex with the possible exception of B_{12} the importance of which for insects has not yet been demonstrated beyond doubt. They do not require vitamins A, C, D, K, and P. The reason that their development is dependent on the presence of the B-vitamins, but not of the others, is obvious. The B-vitamins, in general, function as parts of enzyme systems which are of importance in all living matter. The other vitamins are of importance specifically for the vertebrate organism, presumably because they act in connection with functions which are typical for vertebrates and which insects do not possess – vitamin A, mucous membranes; vitamin C and P, permeability of blood vessels; vitamin D, calcification of bones; vitamin K, blood coagulation. Vitamin E has been shown to play a part in the development of *Ephestia* species; however, this effect is probably unspecific and is that of an antioxidant (9).

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ON THE NUTRITION OF CARPOPHILUS HEMIPTERUS (L.)

by

G.O.STRIDE

Bristol, England

Carpophilus hemipterus (L.) is a Nitidulid beetle that can infest certain stored products, especially dried fruit. It therefore lives under conditions that are rather different from those of most other insects that have been used in nutritional studies. The following is an account of experiments on its nutrition.

In the preliminary experiments the larvae were reared on a diet of dried yeast, casein, glucose, cholesterol, and McCollum's salt mixture No. 185. This dry fraction of the diet was largely based on that used by FRAENKEL & BLEWETT in nutritional studies on other stored products insects (1943). Suitable consistency and water content for *C. hemipterus* larvae were obtained by incorporating 10 % "Cellophas B" solution with the dry ingredients of the diet. Water formed about 50 % of the complete diet. "Cellophas B" (I.C.I.) is a derivative of cellulose. When used to control the consistency of artificial foods with a high water content, it has several marked advantages over agar or gelatin. It is chemically pure, gives a wide range of available consistencies according to the concentration used, and does not liquefy on heating. Foods prepared with "Cellophas B" solution may be rolled out into thin sheets and may be of value during the investigation of the nutrition of leaf-feeding insects.

Under septic conditions the larvae grew well on the following diet:

Food T	20 g
Dried Yeast (Glaxo debittered)	25 g
"Cellophas B" solution	55 g

Food T was prepared by grinding the following dry constituents to the consistency of face-powder:

Casein	19 g
Glucose	41 g
Cholesterol	4 g
McCollum's salt mixture (185)	4 g

The experiments were carried out at 25° C in a relative humidity of 75 %. The larvae were transferred to fresh food each day in order to minimise the effect of micro-organisms. It soon became evident, however, that the latter were interfering to such an extent as would invalidate any results that might be obtained.

A simple technique for rearing the larvae under sterile conditions was devised. This technique apparently excluded external micro-organisms although it would not eliminate any internal symbionts which might be trans-

mitted through the egg. All results quoted below were obtained from larvae reared under sterile conditions unless it is otherwise stated.

It soon became evident that the yeast requirement of the larvae reared under sterile conditions was much greater than had been expected. Foods were prepared containing 50% "Cellophas" solution and 50% of a mixture of dried yeast and Food T. The proportion of dried yeast in this mixture was varied. The growth curves of larvae reared on these foods are shown in Figure 1.

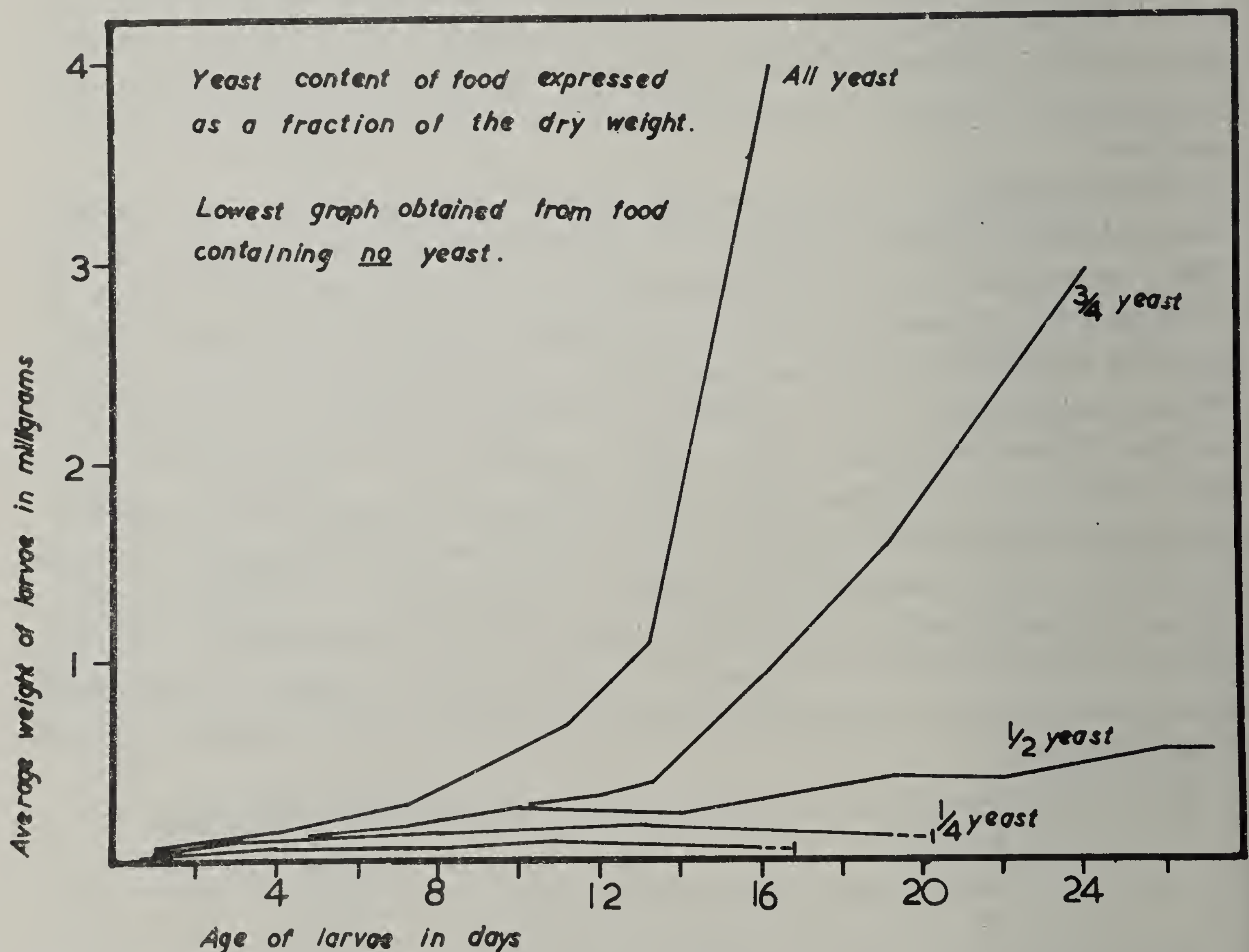

Fig. 1

The fraction shown against each curve referring to the proportion of dried yeast present, e.g., 3/4 = 75% yeast + 25% Food T. It will be noted that growth was very slow even when half the dry fraction was supplied as yeast. This result was probably due, at least in part, to a deficiency in yeast of one or more of the knwon growth factors. Adding a "Vitamin mixture" of known or suspected growth factors to the food containing 50% yeast greatly increased its growth promoting properties. The "Vitamin mixture" contained the following substances: Thiamine, riboflavin, nicotinic acid, pantothenic acid, pyridoxin, biotin, p-amino benzoic acid, inositol, folic acid, tryptophane, thymine, yeast nucleic acid, ergosterol, a-tocopherol acetate. Of the foods used in the above experiment, that composed entirely of yeast gave the most rapid rate of growth. Throughout the entire work under sterile conditions,

however, no artificial food was found on which the larvae would grow as rapidly as they did when they had access to living moulds or yeasts.

The more rapid growth rates obtained with living yeasts may have resulted from either the presence of growth factors destroyed in the preparation of the artificial foods or the higher water content of the living fungi. The difference in the rates, however, seemed too great to result solely from a higher water content of the food. The 50 % water content of the artificial foods was below the optimum water content of foods for *Carpophilus hemipterus*, but was preferred for technical reasons. Incidentally, little or no growth occurred in larvae kept on foods containing 34% water. Figures given by McCANCE & MIDDOWSON (1946) for the water content of dried fruits of a type frequently infested by *Carpophilus* are considerably less than this. It is perhaps significant that early attempts to culture the beetles on raisins as obtained from store failed. When the raisins had been soaked in water, however, they proved to be a very effective culturing medium. Field observations may show that the beetle can establish itself in dried fruit that is in good condition only if the moisture content is high.

The results shown in Figure 1 suggested that dried fruit might not in fact be a nutritionally adequate food for *C. hemipterus*. This was confirmed by experiment. Sterilised eggs were placed on sterilised boiled dates under the following conditions:

i. boiled dates under sterile conditions.
ii. boiled dates + dried yeast under sterile conditions.
iii. boiled dates exposed to infection by micro-organisms from the air.

In ii and iii more or less normal growth occurred. In i no growth occurred after the larvae hat hatched and all died after a few days. Rapid growth under natural conditions is probably more directly related to the presence of micro-organisms than to the presence of dried fruit.

As stated above the larvae grew well on a diet of Food T, dried yeast, cholesterol, McCollum's salt mixture and "Vitamin mixture". When the dried yeast in this diet was replaced by Food T the larvae died soon after hatching and there was no growth. Doubling the quantity of "Vitamin mixture" in the diet did not affect the result of the experiment. If there was a deficiency of one of the components of this mixture in the diet, it was not the sole cause of the failure to support life of the larvae. Rapid growth occurred in those cultures which originally contained no yeast but which became accidentally infected by moulds. There was, therefore, no deficiency of inorganic materials.

Further experiments indicated the presence of at least one essential factor in the yeast residue remaining after extraction of dried yeast with water. The factor or factors were also insoluble in alcohol, ether, petroleum ether, acetone and chloroform. Other experiments, using a less satisfactory technique, suggested that the factor was also insoluble in aqueous solutions of sodium hydroxide and hydrochloric acid. BEGG & ROBERTSON (1950) found that a water insoluble factor present in yeast was an essential nutritional

factor for *Drosophila melanogaster.* They were able to prepare a concentrate of this factor. A concentrate prepared in an apparently similar fashion would not replace yeast in the diet described in the previous paragraph, the larvae always dying unless yeast, or the residue after water extraction, was incorporated. Later it appeared probable that at least two important nutritional factors were present in the yeast residue and one of them may, of course, have been present in the concentrate.

The presence of two important factors is strongly suggested by the results obtained from the following experiment. Yeast was digested with the proteolytic enzyme papain in order to determine whether the unidentified factor was an amino-acid. The digest was separated by centrifuging into soluble and insoluble fractions. These fractions were incorporated both separately and together into foods containing no yeast. The results are shown in Figure 2.

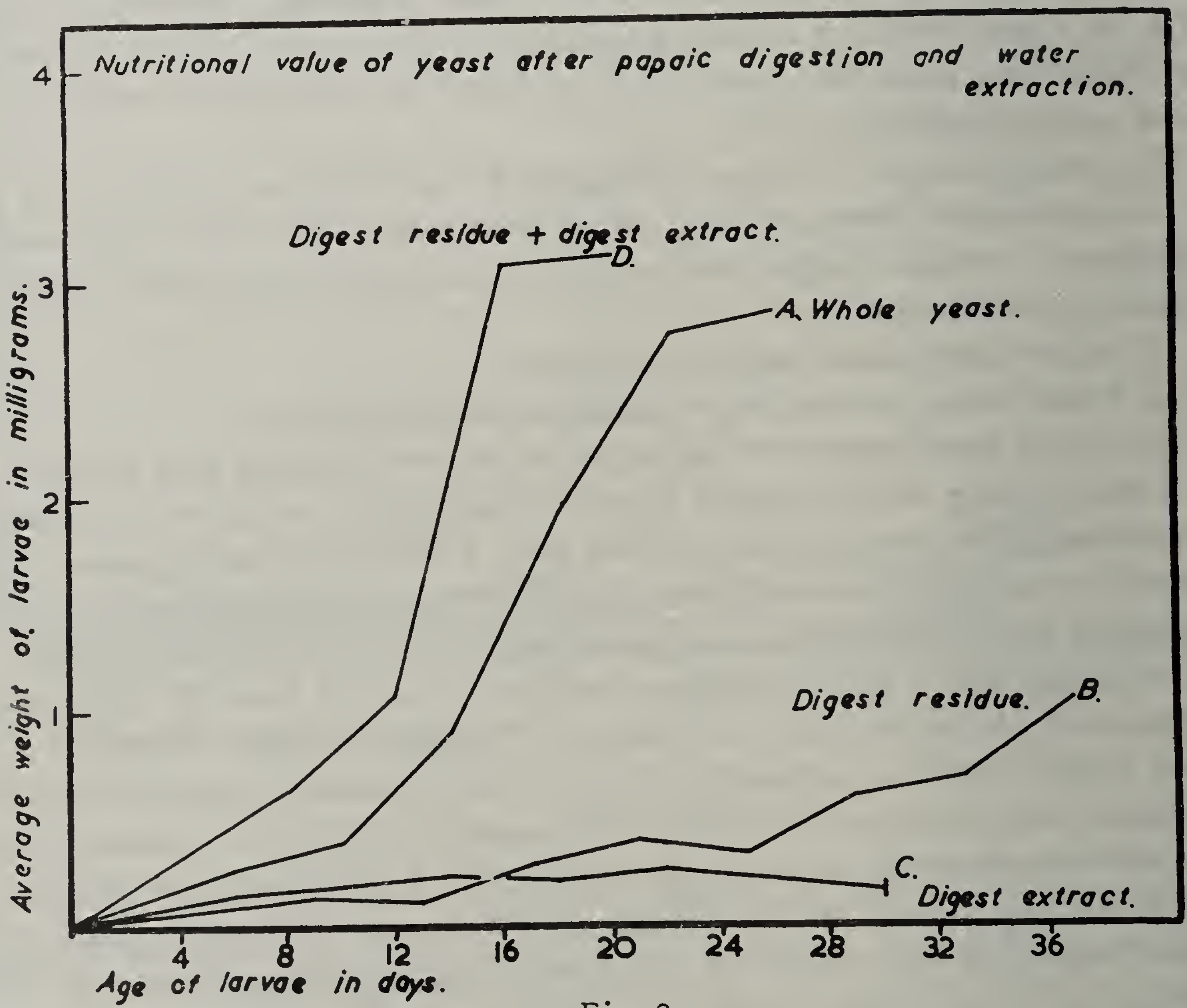

Fig. 2

It will be noted that by itself each fraction failed to promote larval growth. When recombined, however, growth was apparently normal. Equivalent quantities of yeast and soluble and insoluble digest fractions were used throughout this experiment. The results suggest that two factors important in the nutrition of *Carpophilus* larvae were present in the water insoluble fraction of yeast. One of them, possibly an amino-acid, becomes soluble after papaic digestion. The other is still present in the insoluble residue remaining after papaic digestion. Papain was used for this digestion as it has an optimum

pH of about 5.6. This is conveniently near the pH automatically attained as a result of its action on the yeast. It is not possible to attain the low pH required for pepsin in the presence of large quantities of yeast without the addition of chemicals. These naturally cause complications during the feeding tests.

The results shown in Figure 2 may be interpreted in another way, although I think that it is less likely to prove correct. It is possible that the original yeast contained a single unidentified factor in sufficient quantity to promote growth in the larvae. After digestion this factor may have become divided between the two fractions so that neither fraction by itself contained enough of the factor to support growth.

The experiment also provides evidence against the idea that the beneficial effect of the yeast residue is merely due to the presence of an attractive "taste" which stimulates the larvae to consume more of the food.

In order to investigate the importance of the B-group vitamins in the nutrition of the larvae, a control food was prepared which contained Food T, yeast residue (after aqueous extraction), salts, cholesterol, the "Vitamin mixture", and "Cellophas B" solution. Larval growth on this food was compared with growth on a similar food in which one member of the B-group had been omitted from the "Vitamin mixture". In assessing the significance of the results obtained it must be remembered that although a certain factor may have been omitted from the "Vitamin mixture", it may still have been present in the yeast residue.

When riboflavin, nicotinic acid, pantothenic acid, or choline were omitted from the mixture the larvae did not grow after hatching. Except in the case of choline, death occurred after about two weeks. These vitamins are essential for the growth and survival of the larvae.

When pyridoxin was omitted the larvae continued to grow after hatching from the egg but at a slower rate than on the control diet. The mortality rate was abnormally high and nearly all the larvae died before they attained a third of the weight of a normal fully grown larva. Pyridoxin may therefore be classed as an essential growth factor for these larvae.

Omission of thiamine considerably reduced the rate of growth of the larvae. This vitamin is therefore at least of some importance in the nutrition of *Carpophilus hemipterus* larvae.

The omission of biotin, p-amino benzoic acid, inositol, or folic acid had no significant effect on the growth rate. Since these vitamins may have been present in the yeast residue, no deductions may be made regarding their nutritional importance.

In experimental work on the sterol requirements of *Carpophilus hemipterus* a mixture of Food T and dried yeast was extracted with chloroform and acetone to remove the sterols. Extraction was continued with successive quantities of the solvent until the extract failed to give a colour reaction when subjected to the Liebermann-Burchard test for sterols. After this extraction a diet was prepared by incorporating the mixture with "Cellophas B" solu-

tion, "Vitamin mixture", and inorganic salts. The larvae grew reasonably well on this diet. They grew considerably faster, however, when cholesterol or ergosterol was added to the diet. The addition of Vitamin E had no apparent effect on the growth rate.

My thanks are due to Professor J.E.HARRIS and Dr. H.E.HINTON of Bristol University for much helpful criticism during the course of this work and again to Dr. HINTON for reading the manuscript.

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INFLUENCE OF WHEAT VARIETIES ON THE WHEAT STEM SAWFLY, CEPHUS CINCTUS

by

C.W.FARSTAD

Alberta, Canada

ummary

The wheat stem sawfly, *Cephus cinctus* Nort., has been a major pest of ard red spring wheat in the Prairie Provinces of Canada and the adjacent orthern states of the United States. Most of the bread wheats have been ighly susceptible to its attack, and losses amounting to many millions of ushels occurred annually.

In 1932 a research program was initiated which resulted in the production f the variety Rescue, a sawfly-resistant bread wheat, the distinguishing haracteristic of which is its solid stem. This variety was derived from a ross between the standard variety Apex and S-615, a solid-stemmed vulgare ecured from New Zealand.

Only one larva can survive within the culm of the plant. *C.cinctus* then ends itself admirably to a study of the effect of the host on the insect ontained within it.

Throughout this research program the criterion of evaluation of new lines nd varieties was susceptibility to attack. The surviving populations were ery carefully scrutinized. Survival was based on the ability of the larvae develop and eventually cut the stem. Adequately replicated plots were rown at five locations throughout the sawfly-infested area.

The infested wheat stubble was collected and emergence records were ken. The study of the residual populations made possible the evaluation f eacn variety on the basis of infestability, susceptibility, mortality dur- g larval period, female size, oviposition potential, and sex ratio.

In general, the ordinary varieties of bread wheat grown on the prairies e highly susceptible to sawfly attack. Solid-stemmed varieties of either urum or vulgare are resistant. There is a significant difference in the actual mbers of eggs laid per stem in solid stems compared with hollow stems.

Mortality in solid-stemmed varieties occurs either at hatching or in the rly larval stages. It appears as though the larvae hatching from eggs posited within the pith tissue have difficulty reaching the parenchymous ssues upon which they feed.

Widely divergent sex ratios have been found consistently from some rieties. Controlled mating experiments have not explained this phenomenon. ems infested during the last few days of the flight produce a progeny with preponderance of males, which indicates lack of fertilization as being a ntributory factor. Other data, however, indicate that the females may be pable of selective fertilization.

DISCUSSION

Mr. **Lees**: Have you an explanation for the striking differences in sex ratio found in sawflies reared on different lines of solid-stemmed wheat?

Mr. **Farstad**: There is some evidence that this species may be capable of selective fertilization. Both Red Bobs and Golden Ball are varieties with stems of wider diameter than Apex and 4191 respectively.

NEW EVIDENCE FOR AN ECTOHORMONAL CONTROL OF CASTE DETERMINATION IN TERMITES

by
Martin LÜSCHER
Basel, Switzerland

Although much work has been carried out on caste determination in termites, the solution of the problem is not clear *). I therefore undertook a study of the development of supplementary reproductives in the South-European species *Kalotermes flavicollis* Fabr.

The caste of the supplementary reproductives is most suitable for such an investigation since it is produced very regularly in colonies deprived of reproductives.

The developmental potentialities of a nymph are shown in Fig. 1. The direct development leads from stage I to VII and to the alate. It is uncertain whether this direct development really occurs. Normally after reaching the IVth stage growth becomes very slow; the nymphs develop into pseudergates moulting at regular intervals with only very slight or no growth. Most individuals of a colony are of the type of these pseudergates which retain all their potentialities and may develop into alates, soldiers or supplementary reproductives later **).

The supplementary reproductives slightly differ from nymphs and pseudergates. They generally have pigmented eyes and their cuticle is a trifle more yellow. They cannot moult again and are definitely adults. We therefore think that they ought not to be considered as being neotenic nymphs as most authors do ***). They belong to a real adult caste.

If a colony is deprived of the reproductives, the first supplementary reproductives develop after about 8-10 days. Further supplementary reproductives are produced in the following days but their production ceases about 10 days after a male and a female are present. The surplus reproductives are eliminated, being eaten by nymphs or pseudergates. Only one pair of reproductives remains in the colony and becomes sexually mature.

The development of supplementary reproductives is dependent upon the presence of a pair of reproductives. As long as a pair of functional reproductives is present in a colony no supplementary reproductives are produced. But as soon as one of the reproductives, male or female, is taken away, the production of both sexes of supplementary reproductives begins, i.e. the pair

*) See the interesting survey by S.F.LIGHT, Quart.Rev.Biol. 17,18 (1942/43).

**) The pseudergate, a workerlike form, was first described by GRASSE & NOIROT 1947 (C.R.Acad.Sci. 224:219-221).

***) GRASSI & SANDIAS (Atti Acad.Goen.Sc.nat.Catania 6,7, 1893/94), JUCCI (Atti Acad.Lincei, Cl.Sc.Fis.Mat.Nat., Ser.5, 14, 1924), GOETSCH (Vergleichende Biologie der Insektenstaaten, Leipzig 1940), GRASSE & NOIROT (C.R.Acad.Sci. 223:869, 1946).

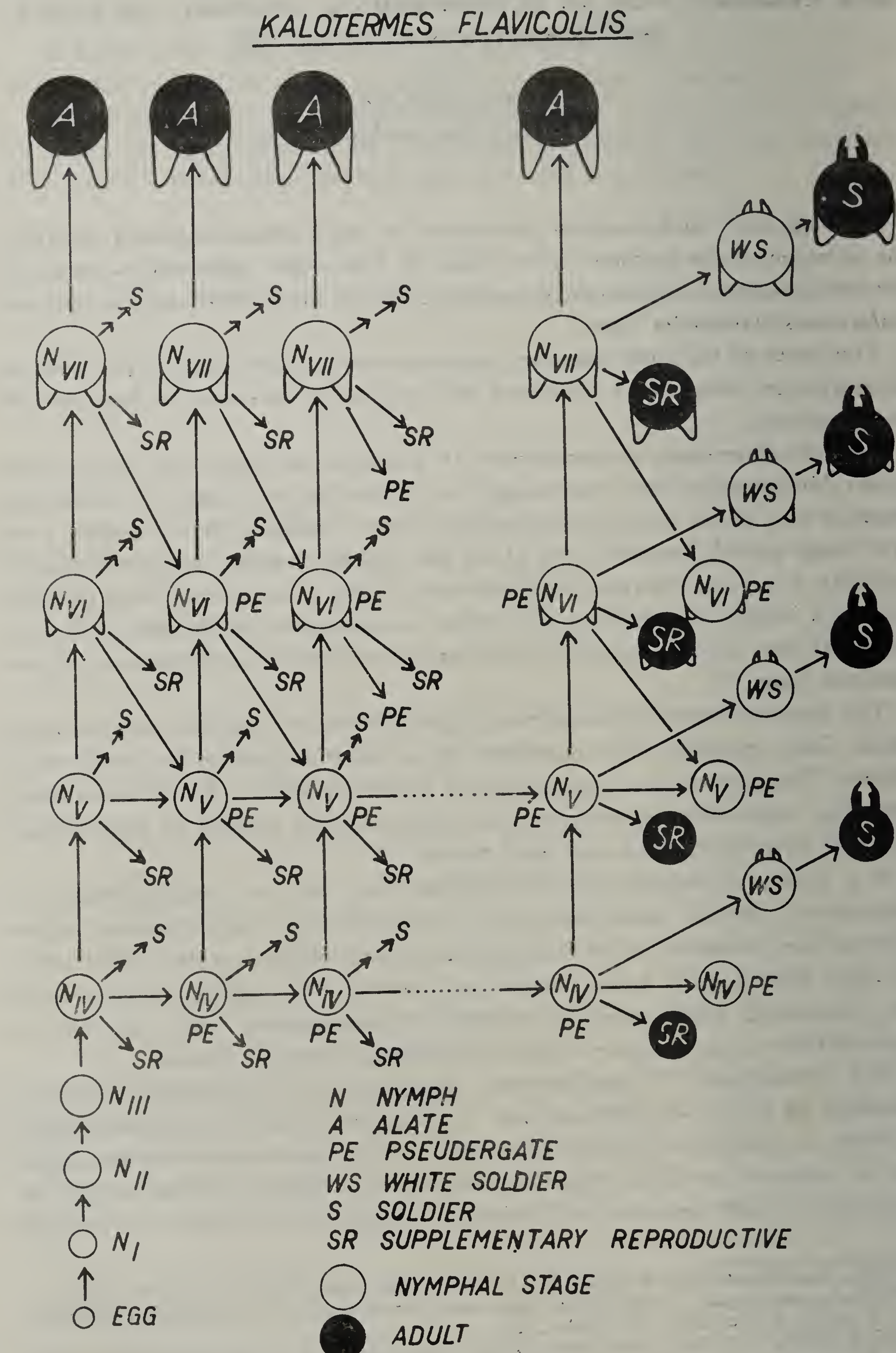

KALOTERMES FLAVICOLLIS
A
S
SR
PE
WS
N VII
N VI
N V
N IV
N III
N II
N I
EGG
N NYMPH
A ALATE
PE PSEUDERGATE
WS WHITE SOLDIER
S SOLDIER
SR SUPPLEMENTARY REPRODUCTIVE
NYMPHAL STAGE
ADULT

Fig. 1

of reproductives has an influence on the colony preventing the production of supplementary reproductives.

GRASSE & NOIROT *) have shown that all nymphs from the 4th to the 7th stage can develop into supplementary reproductives if withheld from the inhibitory influence of reproductives. If this be true it is difficult to understand why the great majority of the individuals of a colony deprived of reproductives remains nymphs or pseudergates. This problem could be investigated by observing colonies in which each individual was marked differently with colour spots. The use of flat glass nests **) made it possible to follow the development of these colonies day by day. By these means it could be demonstrated that the duration of the moulting interval before the moult of a supplementary reproductive is only about a third of that between two ordinary moults (Fig. 2). A nymph or pseudergate which has moulted 45 or more days before the reproductives are taken away will not be transformed into a supplementary reproductive. On the other hand, nymphs and pseudergates which have moulted only a short time (10- 20 days) before the elimination of the reproductives will be transformed into supplementary reproductives with a probability of about 80 %.

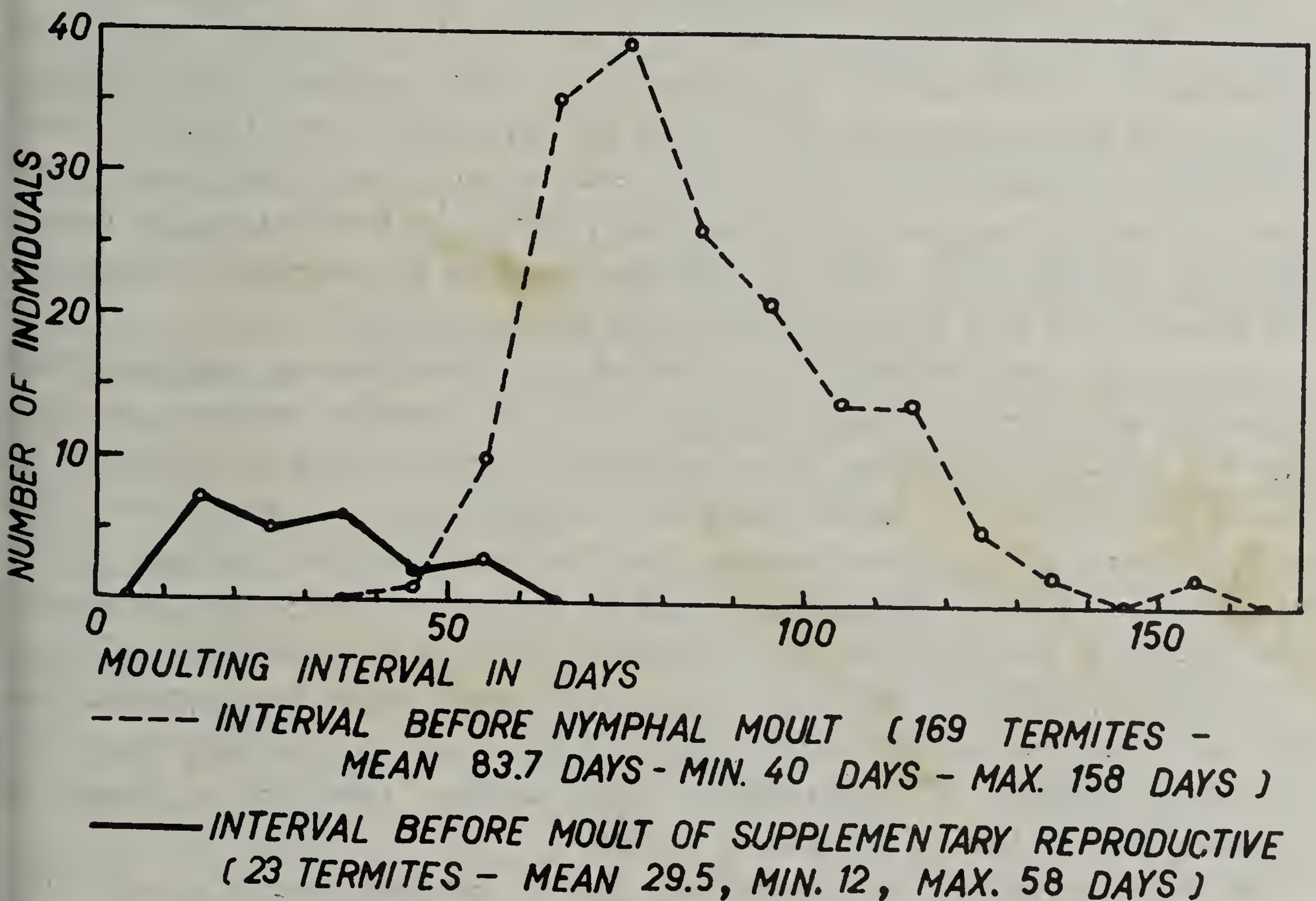


Fig. 2

This proves that all nymphs and pseudergates undergo transformation into supplementary reproductives if they are withheld from the inhibitory influence of functional reproductives during a certain critical period shortly after each

*) C.R.Acad.Sci. 223: 869 (1946).
**) LÜSCHER, Acta Trop. 6 (1949).

moult. This is true only for nymphs which have moulted at least six times. Younger nymphs apparently never develop into supplementary reproductives.

Many authors have supposed that the development of supplementary reproductives is determined by a special kind of food, namely saliva received from the nymphs *), but there is strong evidence against this interpretation since GRASSE & NOIROT **) have shown that isolated nymphs can undergo transformation into supplementary reproductives. There is certainly a direct influence from the functional reproductives on the nymphs which are susceptible to transformation.

Some information on the nature of this inhibitory influence was gained by the following experiment. Two colonies of termites were separated by fine metal gauze through which antennal contact was possible. The termites then show a strong tendency to touch each other through the gauze with the antennae. One of the colonies contained a pair of reproductives, In the other colony supplementary reproductives were produced. In several cases these were then eliminated, being eaten by the other termites – the normal fate of surplus reproductives. New supplementary reproductives were then produced which were also eliminated.

It may be concluded from this experiment that the functional reproductives on the other side of the gauze have been perceived by antennal contact, and consequently the termites have eliminated the newly produced reproductives. Elimination never occurs if the colonies are separated by two layers of metal gauze at a distance of 4-5 mm. from each other. This arrangement makes antennal contact impossible but does not prevent the free passage of odours from one colony to the other. It therefore must be by antennal contact that the termites perceive the reproductives in our experiment.

In spite of this sensory perception of the reproductives, supplementary reproductives were continuously produced. It is therefore evident that it is not the sensory perception of reproductives that prevents a nymph in the susceptible stage from transforming into a supplementary reproductive. This is only prevented by direct contact with the reproductives, probably by an ectohormone which is transmitted either by saliva, by faeces or by exudates. This seems at present to be the only theory which is in accord with all facts.

If there is really an inhibitory ectohormone produced by the reproductives, why is it that the careful experiments of LIGHT and his collaborators ***), in which extracts of supplementary reproductives were fed to groups of nymphs, did not lead to conclusive results?

We have to consider the probability that the ectohormone is a very labile substance which is active for a very short time only, so that the extracts would have to be constantly supplied. This is suggested by the fact that the separation of the reproductives from the colonies for 24 hours only can be followed by the production of supplementary reproductives.

*) GOETSCH, Vergleichende Biologie der Insektenstaaten, Leipzig 1940.
**) C.R.Acad.Sci. 223: 869 (1946).
***) Quart. Rev. Biol. 18: 46-63 (1943).

Another point to consider is the fact that a male and a female must both be present in a colony to prevent the production of supplementary reproductives, i.e. the ectohormone is only produced when a male and a female are together. It is therefore possible that the hormone production ceases or that the hormone is somehow inactivated as soon as the reproductives are isolated for extraction.

For these reasons the extract feeding method is unlikely to provide positive evidence for the ectohormone theory.

Although we have at present no positive proof for the theory of an ectohormonal control of caste determination, there is much evidence in favour of it. In fact we do not know of any other theory which would explain the experimental results.

DISCUSSION

Mr. **Webb**: At what stage can the sex of the individuals of a colony be recognized?

Mr. **Lüscher**: The sex of the supplementary reproductives can only be recognized at the final stage. The sex of the soldiers cannot be determined although there are males and females present.

Mr. **Becker**: Wie ist das Wirksamwerden des Ektohormons bei Verhinderung einer gegenseitigen Fütterung zu verstehen?

Mr. **Lüscher**: Die Larven in der empfindlichen Phase werden durch das Ektohormon daran verhindert, sich in Ersatzgeschlechtstiere zu verwandeln. Das Ektohormon wird nicht durch das Gitter übertragen.

Mr. **Kalshoven**: Have investigations been made or are they planned about the development of the soldiers in colonies that are deprived of them. During the research on *Kalotermes tectonae* in Java I got the impression that there is some kind of regulation?

Mr. **Lüscher**: There certainly is some kind of regulation of the production of soldiers since more soldiers are produced in colonies deprived of soldiers than in those containing soldiers. The problem of soldier development is much more difficult to attack than that of supplementary reproductives since soldiers are produced very irregularly and the soldier production is also dependent on seasons. Investigations of this problem are planned but they will be carried out only when the production of supplementary reproductives will be better understood.

Mr. **Agrell**: Why is the substance called a hormone, whilst it does not exert its action through the blood and from blood to blood?

Mr. **Lüscher**: The term ectohormone has been used in this connection by LIGHT and many other authors. It is thought that the substance would enter the blood of the nymph getting it, and exert its action in interacting in some way with the hormones controlling moult and metamorphosis.

Mr. **Buchli**: First this statement: The idea of the test with a metal net-

work between normal and orphan colonies has been created by Prof. GRASSE, who asked me summer 1949 to carry out experiments concerning this test with a network on *Reticulotermes*.

Other observations however have stopped these experiments. I have evidence that such a thing as inhibition in the production of neotenic reproductives does not exist in the case of *Reticulotermes*.

I observed that neotenic reproductives are developed in presence of the royal imaginal couple. I can produce this development whenever I want in young incipient colonies possessing the imaginal royal couple. But I have also observed that either the newly formed neotenic reproductives or the royal imaginal couple are killed by the colony if there is not sufficient living space given to the colony. If I provide for a lot of space, then the royal couple or the neotenics get away, and as soon as they are separated the colony seems to split into two fractions, being in loose contact only with each other, and both kinds of reproductives are tolerated.

I cannot believe now that there are such fundamental differences in caste determination between *Kalotermes* and *Reticulotermes* as to account for the differences in their development.

I can definitely say that if inhibition should exist, it has extremely little effect on *Reticulotermes*. How on the other hand does Mr. LÜSCHER explain with this hormone theory that in spite of the metal network neotenics are formed but that they are then killed. If absence of hormone allows their development, why are they not tolerated?

SOME DATA ON THE COMPOSITION OF THE WAXY LAYERS ON EGGS OF THE EUROPEAN RED SPIDER IN DIFFERENT STAGES OF DEVELOPMENT

by

G.F.E.M. DIERICK

Amsterdam, Netherlands

Experiments of SLIFER in 1946 showed that the diapause in eggs of the grasshopper, *Melanoplus differentialis* Thomar, can be broken when the eggs are brought into xylene for about 30 minutes. Other wax solvents have a similar effect. She states that the xylene dissolves the wax present on the hydropyle, a pore in the egg shell, so that water uptake, necessary for further development, can take place.

On the strength of these results we have made a similar experiment regarding the possibility of breaking diapause in winter eggs of the European red spider (*Metatetranychus ulmi* Koch).

The first results obtained were published in 1950. It was found that as early as November 30th, when the first experiment was carried out, washing with xylene had a marked effect on the moment of hatching of the red spider. Within the first 21 days after the treatment 85 % of the viable eggs treated for 20 minutes had already hatched, whereas in the blank only 10 % hatched within that time.

Replications of the experiment, however, often showed great variations. We, therefore, compared the effect of xylene with that of chloroform and stored the eggs after treatment under different conditions of temperature and air humidity. As chloroform is known to be a much better solvent, only very short washing times were used. The percentages of the viable eggs that hatched within the first 21 days when stored at 20° C or within the first 35 days when stored at ca 15° C can be seen in table 1. A 1 minute treatment already has some effect and a 5 minutes' wash results in a hatch of almost all the eggs within the first period.

Since it is now clear that diapause of red spider winter egg can be broken by a relatively short treatment with a wax solvent it was interesting to investigate what factor governs the natural breaking of the diapause. Could it be that removal of some waxy material present on the egg shell gives rise to a start of the development or is the action of the solvent a chemical stimulant? What happens in nature where diapause is broken during a winter storage of several months?

In view of the success in breaking diapause artificially by a wax solvent we arranged some experiments to detect any possible change in the amount or composition of wax of the egg shell with proceeding development.

To this end large amounts of isolated winter eggs in different stages of development and also summer eggs were extracted with a wax solvent. These

Table 1

Rate of hatching of red spider winter eggs after treatment with chloroform

Stored at		Control after	% Hatch of viable eggs						
			Blank	after treatment with					
				xylene for			chloroform for		
°C	% RH			10 min.	20 min.	30 min.	1 min.	2 min.	5 min.
20	ca 50	21 days	16	25	6	16	45	65	92
20	95	21 days	24	53	41	50	54	74	93
ca 15	80	35 days	11	32	22	16	49	73	71
ca 15	95	35 days	25	13	12	22	35	42	81
% viable eggs			52	51	52	46	56	60	65

Table 2

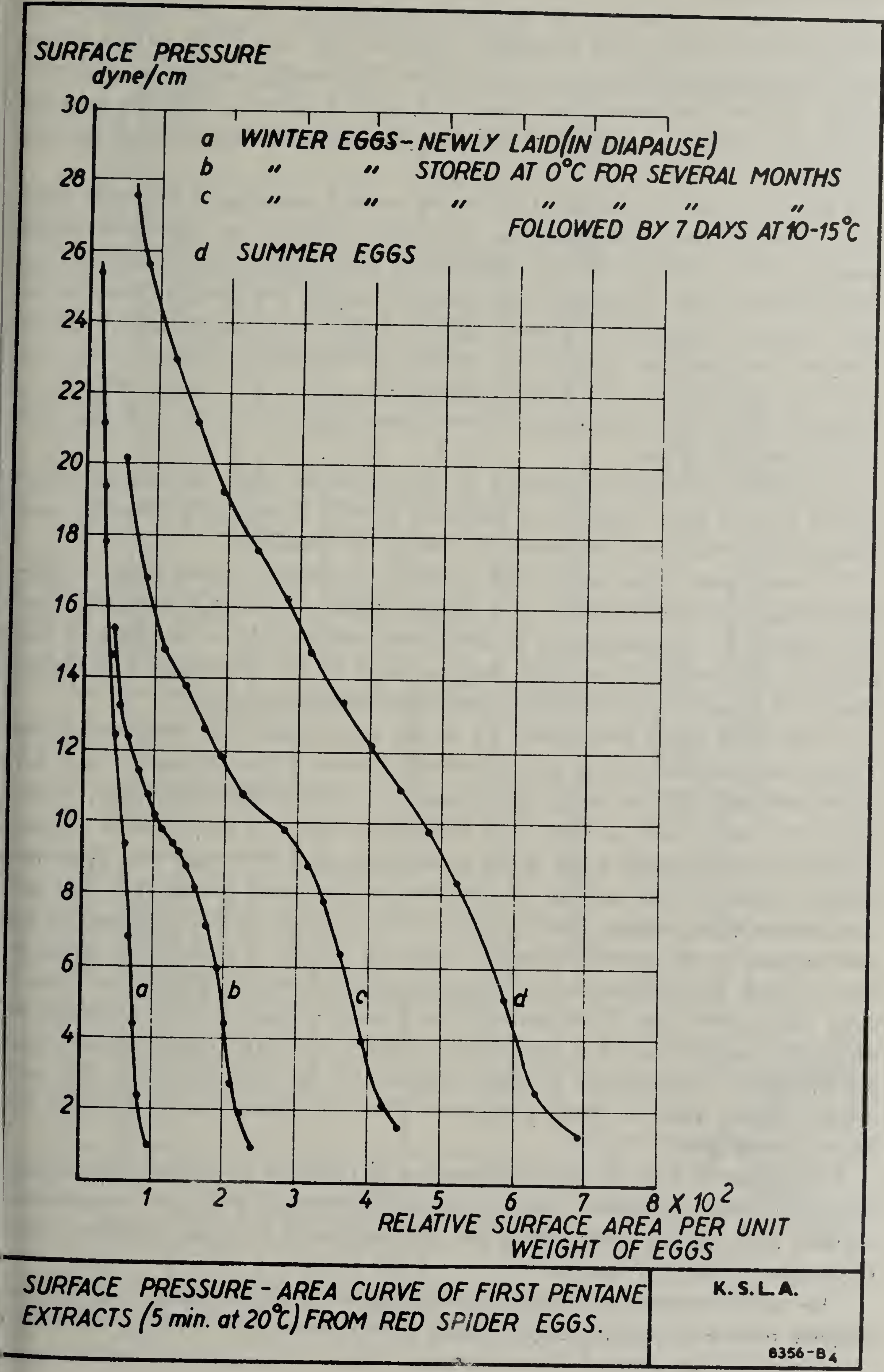
Dats on spreading experiments of pentane extracts

Kind of eggs	spread area / egg surface	
	first 5 min. extract	total extract
winter egg in diapause	90	210
winter egg stored 2 months at 0° C	240	550
winter egg stored 2 months + 3 days at 10-15°C	380	800
winter egg stored 2 months + 5 days at 10-15°C	400	1260
winter egg stored 2 months + 7 days at 10-15°C	450	920
summer egg	690	1400

extracts were used for spreading experiments on a Langmuir trough on 0.01 n HCl. For these tests pentane was used as the solvent for washing the eggs, since for spreading experiments a very volatile solvent has to be used.

We now found that the area covered by the monomolecular film at a special pressure, for instance about 1 dyne/cm, was much larger for the extracts from summer eggs than for those from winter eggs and that also during development of the winter egg the area covered by the extract increased (Table 2).

Furthermore the curve (graph 1) obtained when the relative value for the surface area of the wax per unit weight of the eggs is plotted against the spreading pressure shows that the total surface covered by the pentane


SURFACE PRESSURE
dyne/cm
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
a WINTER EGGS-NEWLY LAID(IN DIAPAUSE)
b " " STORED AT 0°C FOR SEVERAL MONTHS
c " " " " " " "
FOLLOWED BY 7 DAYS AT 10-15°C
d SUMMER EGGS
a
b
c
d
1
2
3
4
5
6
7
8 X 10 2
RELATIVE SURFACE AREA PER UNIT
WEIGHT OF EGGS
SURFACE PRESSURE-AREA CURVE OF FIRST PENTANE
EXTRACTS (5 min. at 20°C) FROM RED SPIDER EGGS.
K.S.L.A.
8356-B4

Graph. 1

extract monolayer is not only larger when the eggs become older and development starts, but the curves are more complicated too. The impression is obtained that at high film pressures the behaviour is similar to that of the newly laid eggs and that the amount of the film-forming material is not much larger. At low film pressures, however, a second material might be present in the film which is dispelled from the film at surface pressures of 8-10 dyne/cm.

Whereas we at first thought that for the natural breaking of diapause some waxy material would disappear, as with wax solvents, the above-mentioned results rather indicate that an increase in wax content during storage and development of the winter egg takes place. Another possibility, however, is that a special wax that is already present when the egg goes into diapause changes its chemical composition during development and that, while the first wax could make the shell impermeable to water or gas exchange – whatever the cause of the stop in development might be – the new one does not produce this effect.

It therefore seemed interesting to learn whether there is indeed an increase in total waxy material of the shell or only a change in chemical composition of already existing material, during development.

To investigate this, again large amounts of isolated winter eggs in different stages of development were extracted but now more thoroughly, first with xylene for 20 minutes to compare the reaction of the breaking of diapause by this wax solvent, and then followed by an extraction with chloroform for a whole day. Both extractions were carried out at 20°C.

It was then found that about 2% of the egg weight was extracted in the xylene and another 12% in the chloroform. However, these amounts did not differ substantially for eggs in diapause or in post-diapause stage. Also SLIFER (1948) tried to show that differences exist in the amounts of wax obtained from diapause eggs of the grasshopper and from eggs with diapause broken, but since the amount of wax was so small and the error in this determination high, nothing final could be said concerning any changes during development in the quantity present. From our results it seems most probable that no new wax formation has taken place but that the change in surface area and in the type of pressure curve should be ascribed to a change in chemical composition of a part of the existing wax. The newly formed compound would then occupy a larger surface in the monomolecular film and would not be able to stand pressures above 10 dynes/cm in such an inhomogeneous film.

It was possible to get more information on this wax by dividing the xylene and chloroform extracted waxes into an acetone-soluble and acetone-insoluble part and by determining the melting points of these different fractions. See Table 3.

The acetone-soluble fractions consisted of a rather tough material of slightly brownish colour; their melting points were most difficult to determine, probably because they are mixtures whose compounds crystallize more

Table 3

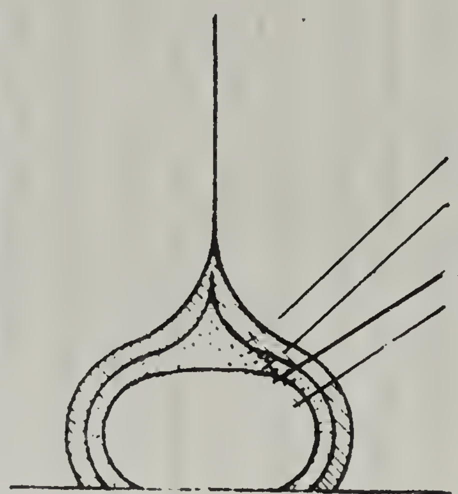
Solubility in acetone and melting points of extracts

Kind of egg	Xylene extract			Chloroform extract			% Egg weight of all extracts	
	% total weight	% acetone-soluble	% acetone-insoluble	% total weight	% acetone-soluble	% acetone-insoluble	% acetone-soluble	% acetone-insoluble
winter egg in diapause	2.1 *)	88.4 m.p. ca 80° C	18.4 m.p. 185-190° C	9.8 m.p. 167° C	15.7 m.p. 43-80° C	85.9 m.p. 169° C	3.4	8.8
winter egg post-diapause	1.85 m.p. ca 75° C	m.p. 40-65° C	15,3 m.p. 185-190° C	12.1 m.p. 166-167° C	17.1 m.p. 45-55° C	83.9 m.p. 166.5° C	3.4	10.4
winter egg post-diapause some started hatching				14.8 m.p. 166° C	31.2 m.p. 45-50° C	69.4 m.p. 166° C	4.6	10:2
summer egg				25.5 m.p. 161° C	60.4 m.p. <-15° C	39.6 m.p. 170° C	15.4	10.1

*) at 140° C still solid, dark discoloration, decomposition of the wax starts.

Table 4

Localization of the waxes on the shell of the fruit tree red spider egg (according to BEAMENT)



outer wax layer : 1 µ wax: melting p. 171° C } leaving a hole un-
cement layer : 1 µ protein + wax } covered at the bottom

inner shell layer: 0.5 µ protein (S linkages) } surrounding the
inner wax layer : wax with transition point 68° C } yolk entirely

or less separately. The acetone-insoluble fractions, on the other hand, were white hard waxes with a fairly sharp melting point.

The part that should interest us most is the xylene extract, since by a 20 minutes' xylene washing it has been possible to start development in a diapause egg. In regard to these extracts we now see in the acetone-soluble fraction a marked decrease of the melting point with proceeding development. The acetone-insoluble part, however, does not show any difference.

In the chloroform extract we can still see a decrease in the melting points of the acetone-soluble fraction with proceeding development, so that probably not all the xylene-soluble wax was extracted within 20 minutes. The acetone-soluble part of the summer egg wax even shows a very low melting point. The acetone-insoluble fractions show hardly any difference.

These results may indicate that since the melting points of the acetone-soluble fraction of the winter egg shell decrease with increasing development and since also the summer egg has a very low melting acetone-soluble material in its shell, diapause in the winter egg will most probably be caused by an inhibition of gas or water exchange caused by a rather high melting, acetone-soluble wax covering the egg content entirely or partly. This diapause wax would be decomposed during the diapause stage into a lower melting compound making the shell more permeable, thus permitting further embryonal development. The acetone-insoluble fractions do not seem to play a part in the problem of diapause.

We now have to realize that this diapause wax is only present in a small amount – possibly about 2% of the egg weight –, while the total amount of the wax on a winter egg shell is about 14%. It may therefore be of interest to make a hypothesis of the position of the diapause wax on the egg surface as, because of its quantity, it can only be present in a thin layer or on a part of the shell surface.

Recently BEAMENT (1951) made an extensive study of the composition of the red spider egg shell and of the way it is formed around the egg. See Table 4.

When the egg is laid, it is primarily surrounded by the inner shell layer that covers the yolk entirely. During oviposition two outer membranes are formed: the cement layer and the outer wax layer (both about 1 µ thick), both leaving a hole open at the bottom where the egg sticks to the twig. Inside the inner shell layer there is an inner waxy layer that makes the egg impermeable towards water, having a transition point at 68° C. In a winter egg this inner wax layer is already present at the time of oviposition, in a summer egg only from 6 hrs after oviposition. This is according to BEAMENT the only difference between both eggs in regard to their shells.

It is most probable that the 1 µ thick outer wax layer of melting point ca. 170° C from BEAMENT's data corresponds with the acetone-insoluble wax with melting point 166-170° C which amounts to 10% of the egg weight.

In our experiments the inner wax layer will not be extracted as solvents do not penetrate so rapidly through the inner shell layer.

Thus from the data given by BEAMENT and the results obtained from our own investigations we believe that there are three likely answers to the question where the diapause wax will be localised, i.e. either as matrix in the cement layer or at the rim of the hole where the egg sticks to the twig, or on the surface of the hole itself. The latter is the most likely, however, since in the first place – as an argument against localisation in the cement layer – wax incorporated in a layer protected by another waxy layer of 1 μ thickness would not be extracted so easily that more than 50% would be removed during a 20 minutes' xylene washing; in the second place – as an argument against localisation at the rim where the egg sticks to the twig – eggs that are removed from the twigs still remain in diapause during the usual time. This leaves us only the hypothesis that the diapause wax will be present on the surface of the hole, where it moreover can easily be reached by wax solvents.

This suggestion that the diapause wax is located on the outer surface of the hole that is left open by the two outer shell membranes is furthermore in satisfactory agreement with SLIFER's opinion that in grasshopper eggs diapause can be broken by removal of a waxy substance covering the hydropyle (the pore in the egg shell).

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DISCUSSION

Mr. **Lees**: Is it not possible that xylol serves to stimulate the development of the diapause eggs, as might other kinds of "shock" treatment? Are you certain that its effectiveness in breaking diapause has necessarily any connection with its action as a wax solvent?

Miss **Dierick**: In his experiments BEAMENT proved that chloroform does not penetrate through the inner shell layer in a much longer time than used in our experiments since he did not find a difference in transition point; it therefore does not seem probable that the effect of the wax solvents has been a chemical stimulant.

Mr. **Le Berre**: La rupture de la diapause est elle due à une „perméabilisation" de l'enveloppe de l'oeuf, à l'eau? Chez les oeufs à diapause de *Locusta migratoria* subsp. *gallica* (Rem.) l'oeuf „déchorionné" selon la méthode de SLIFER doit demeurer une trentaine de minutes dans le xylol, pour qu'il y ait réactivation. De plus, si des oeufs non-„déchorionnés" demeurent entre 5 minutes à 4 heures et plus dans le xylol, il n'y a pas élimination de la diapause.

Miss **Dierick**: It is not known what exactly causes the start in development of the eggs, whether it is an increase in the permeability of the shell towards water on some other factor.

For red spider eggs a removal of an outer membrane of the shell is not necessary for the treatment with a wax solvent to be a success; this seems to be necessary however for grasshopper eggs (SLIFER) and for the eggs of *Locusta migratoria.*

EFFETS PARASYMPATHYCOLITHIQUES DE L'ATROPINE SUR LES MUSCLES LOCOMOTEURS DE CHENILLES DE LEPIDOPTERES

par

Glauco REALI

Milano, Italia

Je viens rapporter sur les effets que trois alcaloïdes, l'atropine, la pilocarpine et l'ésérine, ont sur les chenilles des Lépidoptères, avec une particulière référence à la transmission myo-neurale, et sur l'interférence que les centres nerveux supérieurs démontrent avoir sur l'action de tels alcaloïdes.

Les épreuves ont été exécutées sur des chenilles de *Galleria mellonella* L., auxquelles on donnait les substances par injection et dont on observait les réactions soit directement, soit par un enregistrement myographique, au moyen de myographes particulièrement adaptés: on opéra sur des chenilles entières et sur des chenilles privées des centres nerveux supérieurs (céphaliques et thoraciques). Les substances ont été introduites dans la cavité célomatique soit seules, soit mélangées entre elles.

Les résultats de l'expérimentation peuvent se résumer comme suit:

Dans les chenilles entières :

1. L'atropine donne d'abord une excitation nerveuse, qui est suivie de la paralysie des muscles de la locomotion et par le relâchement de tous les muscles;
2. Dans la phase de relâchement, certains muscles conservent l'excitabilité, qui est capable de donner un accourcissement temporaire à la chenille soumise à de faibles stimulations mécaniques appliquées sur l'épiderme;
3. En provoquant des pressions à large surface, on n'obtient aucune réaction dans la chenille atropinisée, présentant une plasticité remarquable, démontrée par un état de paralysie même aux muscles de la turgescence;
4. La pilocarpine donne une excitation initiale, suivie d'une immobilité presque absolue: les muscles maintiennent cependant un considérable pouvoir d'excitation. Les expériences n'ont pas donné des résultats probatoires: d'après une observation superficielle on pourrait même conclure qu'atropine et pilocarpine produisent les mêmes effets. Cet apparent paradoxe sera expliqué en comparant les actions des deux substances sur des chenilles privées des centres nerveux supérieurs.
5. L'ésérine, qui produit le blocage des cholinestérases, excite indirectement les muscles, soumis continuellement à l'action du principe cholinergique qui augmente pendant tous les temps; c'est pourquoi les contractions musculaires continueront jusqu'à la mort de l'insecte;
6. Au moins pour les muscles de la locomotion, l'ésérine est l'antagoniste de l'atropine.

Dans les chenilles privées des centres nerveux céphaliques :

1. L'action de l'atropine résulte évidemment contrastée. Les réactions prolongées sous des stimulations très faibles, et le comportement du tonus musculaire, ont mis en évidence un pouvoir d'inhibition à l'action atropinique, opéré par les centres thoraciques;

2. La pilocarpine ne trouve pas de contrastes à son activité excitante.

Dans les chenilles privées des centres nerveux céphaliques et thoraciques l'action des alcaloïdes est caractéristique et différente pour chaque alcaloïde et elle se manifeste tout de suite après leur injection.

Les faits que j'ai présentés semblent indiquer que les centres céphaliques et thoraciques démontrent soit une activité qui règle le mouvement musculaire, soit un pouvoir de compétition entre eux:

1. Les centres thoraciques s'opposent à l'action de l'atropine, qui peut agir complètement comme paralysante dans les chenilles privées des centres supérieurs (céphaliques et thoraciques);

2. Les centres céphaliques sont d'obstacle aux centres thoraciques : en effet dans les chenilles entières on obtient paralysie après une excitation;

3. Les centres céphaliques s'opposent à l'action de la pilocarpine, qui peut agir complètement dans les chenilles privées des centres céphaliques, ou bien céphaliques et thoraciques, et non dans les chenilles entières;

4. Les muscles de la locomotion et de la turgescence des chenilles de *Galleria mellonella* L. (et, peut-être, même des larves des Lépidoptères en général), sous l'action de l'atropine ont une réaction semblable à celle des muscles parasympathiques des vertébrés.

DIURNAL RHYTHMS

by

J.L.CLOUDSLEY-THOMPSON

London, England

It has long been recognised that some insects are active only in the daytime, others at dusk or during the night, but it is only in recent years that the phenomenon of 24 hour periodicity in animals has attracted much attention. Although the existence of rhythmic behaviour has been established in many species, as CALHOUN (1944) points out in a review of the subject, research has been carried out by physiologists, ecologists and psychologists, with scant unification of effort.

Diurnal rhythms are basically of two kinds; exogenous, a direct response to environmental changes; and endogenous rhythms which persist under constant conditions. PARK (1940, 1949) subdivides endogenous rhythms into 'inherent' (i.e. genetical) and 'habitual' ones. CALHOUN (1944) however considers all endogenous rhythms to be of the latter category because the genetical determination of 24 hour periodicity has in no case been demonstrated. Although GUNN (1940) found that a few cockroaches raised in continuous darkness and constant temperature showed a clear 24 hour rhythm, he pointed out that the experimental cabinet may not have been completely light-tight, and the animals were only inspected during the daytime. In the present state of knowledge it is perhaps advisable to withold judgement on this point.

The majority of species however, show a combination of both types, and such rhythms are designated 'composite' (PARK, 1949). The differences between the main types of rhythm under varying conditions, are illustrated in text-fig. 1.

Endogenous rhythms are frequently correlated with environmental changes although they are not necessarily a direct response to them. Thus if the cockroach *Blatta orientalis* L. is subjected to alternating 12 hour periods of light and darkness, its activity is largely confined to the latter, although locomotion may actually begin shortly *before* the light is extinguished. (GUNN, 1940; MELLANBY, 1940). This activity rhythm persists for some days in continuous light or darkness, but eventually becomes more evenly spread over the whole day leaving only a slight residual rhythm which is unrelated to the previous conspicuous one. Perhaps this is a true 'inherent' rhythm.

Gryllus domesticus L. and *G. assimilis* L. too have been shown to have a marked nocturnal activity pattern which persisted in constant darkness, high humidity, and only 2° C daily variation in temperature (LUTZ, 1932). This fluctuation may however explain the curious reversion to a normal rhythm shown by two specimens of the latter species after four days in constant

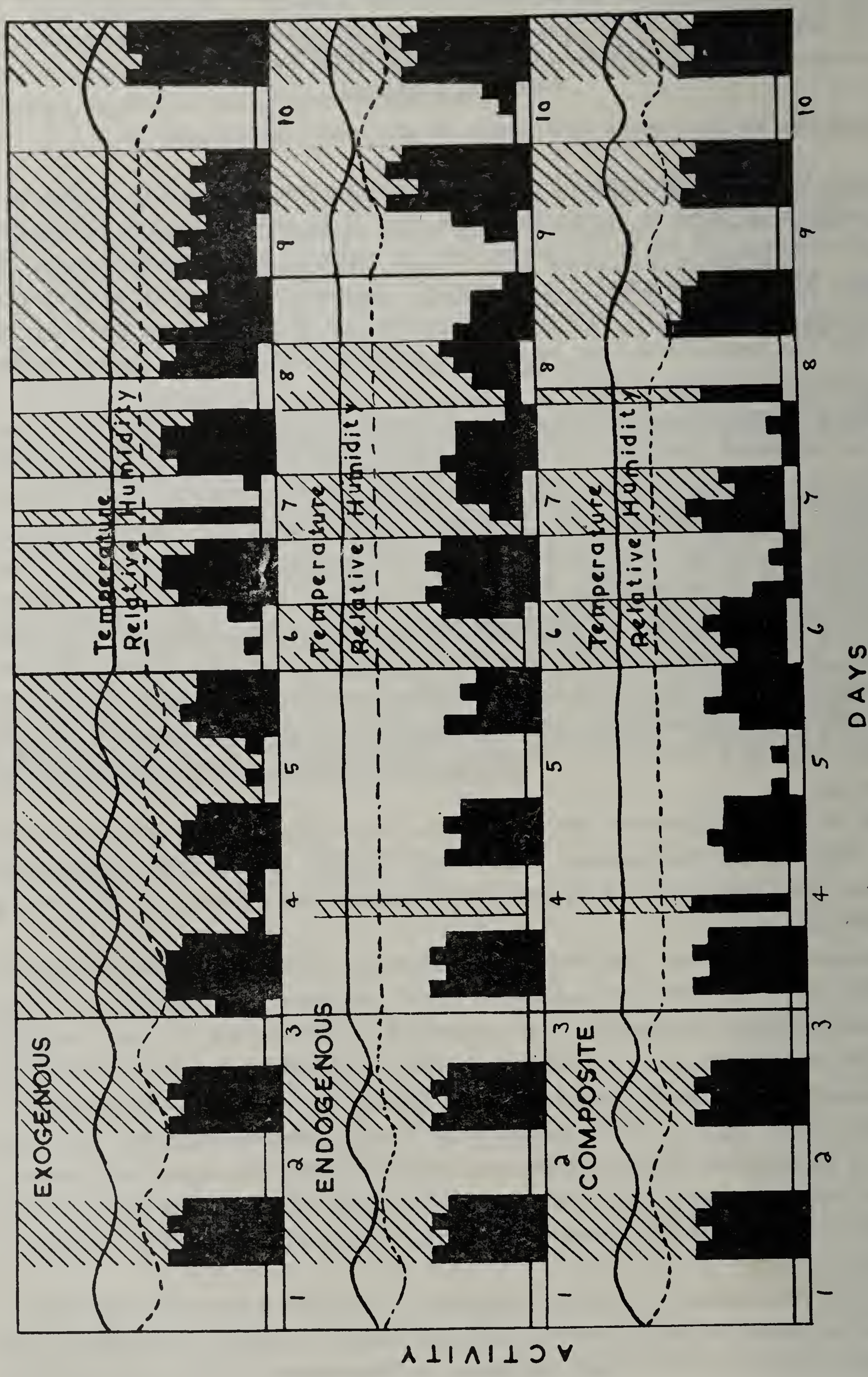

Fig. 1. Hypothetical diagram to illustrate the effect of altering environmental conditions on the locomotory activity of a nocturnal animal with an exogenous, endogenous, and composite diurnal rhythm.

darkness, though they had previously exhibited a reversed rhythm (BENTLEY, GUNN, & EWER, 1941). Although in its normal habitat the grain beetle *Ptinus tectus* Boild. is arhythmic, in alternating light and darkness the greatest amount of activity occurs during the latter period. If the light is constant however, and the temperature fluctuates, the greatest activity occurs when the temperature is falling; and after transfer to a constant temperature this period still occurs at the same hour for several days (BENTLEY, GUNN, & EWER, 1941). Similarly not only is falling temperature a stimulus to orthokinetic locomotory activity in millipedes (CLOUDSLEY-THOMPSON, 1949, 1951b.) but it is correlated with the diurnal rhythm. The British species *Blaniulus guttulatus* Gerv. and *Oxidus* (*Paradesmus*) *gracilis* (C.L.Koch) have a simple exogenous rhythm which is primarily a response to the normal cycle of light and darkness, but this effect is enhanced in proportion to the drop in temperature which occurs in the evening. In contrast a West African species of *Ophistreptus*, and *Oxydesmus platycercus* Attems. both show an endogenous periodicity under constant contitions which in the former may persist up to 19 days. This locomotory rhythm is stimulated by increasing and decreasing temperature, but is not affected by alternating 24 hour periods of light and darkness (CLOUDSLEY-THOMPSON, 1951a). PARK (1935) found that in the large tropical millipede *Spirobolus marginatus* (Say) closely marked cycles of activity persisted under constant conditions during starvation for periods up to 18 days, indicating that the activity was not associated with feeding.

We have therefore the concept of an innate or endogenous rhythm correlated with, but not necessarily stimulated by environmental changes. Indeed the latter are better regarded as 'clues' than as stimuli, and their importance lies in the maintenance of the rhythm and in keeping it in phase with the environment.

A somewhat different rhythm is seen in the moulting of insects, the hatching of their eggs and emergence of pupae. These proceedings usually occur at a definite time of day and will continue to do so for several generations under constant conditions (for references, see WIGGLESWORTH, 1950). No doubt these, like the endogenous rhythms described above, are closely connected with metabolic rates.

The environmental changes which are known to act as stimuli for exogenous, and as clues for endogenous diurnal rhythms, are light, temperature, and possibly humidity. UVAROV (1931) has shown that fluctuations in atmospheric pressure are unlikely to have any significance. In most cases it seems likely that more than one factor is involved, and this may be the explanation of the results obtained by MELLANBY (1939) for the bed-bug *Cimex lectularius* L. in which activity increased steadily during the night to reach a peak at dawn; but was not directly correlated with variations in light, temperature, or humidity. Apparently different factors are of primary importance in different species.

That bees have an exogenous factor in their diurnal rhythm is shown by

the unique observation of NEWPORT (1837) during a total eclipse of the sun. When the sky darkened and the temperature dropped, the hive was quiet as at night. Full activity was resumed when the eclipse was over. On the other hand, the fact that bees have a time memory and can be trained to feed at regular intervals suggests that in this case the rhythm is again composite. Furthermore ants which are generally arhythmic have been trained to feed at several time intervals, whilst bees which have a marked rhythm and are active only in the daytime, cannot be trained other than on a 24 hour basis.

Another factor to be considered is that although many species are active during a certain period of the day or night, and are quiescent for the remainder of the 24 hours, others exhibit different kinds of activity at different times. Thus the water-skater *Gerris rufoscutellatus* Latr. spends the daytime on the surface of ponds and streams, but flies from one locality to another at night (RILEY, 1925), and many other aquatic insects such as beetles fly mostly at night, but swim actively throughout the day.

Students of the behaviour and orientation of animals cannot really afford to neglect diurnal rhythms, since the responses of an animal to its environment may vary at different times. For example SZYMANSKI (1914) found that during the active phase of its diurnal periodicity the well known responses of *Blatta orientalis* to light and temperature seem to disappear, and the insect becomes indifferent to its surroundings.

Diurnal changes in physiological responses have recently been investigated in the woodlouse *Oniscus asellus* L. which has a composite diurnal locomotory rhythm correlated primarily with alternating light and darkness, and not with fluctuating temperature and humidity.

The intensity of the humidity responses of this species is greater in darkness than in light, and is greater still in the nocturnal phase; it increases with desiccation. The photo-negative responses are greater in animals which have been in darkness for some time, and such animals tend to remain negative in dry air whereas controls became photo-positive with desiccation. Finally the active phase is correlated with increased sensitivity to external conditions such as the CO_2 content of the air. These experimental results are readily correlated with the nocturnal ecology of the species. Woodlice are often to be seen wandering in dry places at night, but they spend the daytime under stones, logs, and in other damp, dark situations where environmental factors are relatively constant. If nightfall only involved a reduction of the conditions which normally operate to restrict them to their daytime habitats, it seems unlikely that they would have occasion to leave them. The endogenous component of the diurnal rhythm however, will engender locomotory activity in some individuals at least, at nightfall when they are especially sensitive and easily disturbed. Even if the majority are exposed to daylight only occasionally, this may be sufficient to maintain their periodicity, and keep it in phase with the 24 hour cycle, The decrease in the intensity of the humidity response enables them to walk in dry places

where they are never to be found during the day; and the increased photo-negative response in darkness ensures that they get under cover promptly at daybreak, and thus avoid many potential predators. On the other hand if their daytime habitat should dry up, the woodlice are not restrained there until they die of desiccation, since they become photo-positive in dry air and thus are able to wander in the light until they find some other damp, hiding place, and again become photo-negative (CLOUDSLEY-THOMPSON, 1952).

The pill-woodlouse *Armadillidium vulgare* Latr., which is more resistant to desiccation than other species of Isopoda, shows locomotory activity principally in the morning when it is often to be seen walking about in the bright sunlight. This is probably correlated with the fact that in this species some individuals exhibit positive photo-taxis when the sun rises (CLOUDSLEY-THOMPSON, 1951c).

Many species tend to become depressed if isolated under constant conditions for long periods. For example Dr. H.W. LISSMANN informs me that amphibians and reptiles do not thrive in vivaria unless there is some fluctuation of the temperature. Similarly under constant conditions a steady decline in total activity during each 24 hour cycle occurs in millipedes (CLOUDSLEY-THOMPSON, 1951a), and in cockroaches (unpublished). If two cockroaches, even of different species (*Periplaneta americana* L. and *P. australasiae* Fabr., are kept together, the depression does not set in so readily. Nor does it appear if there is a 24 hour cycle of temperature fluctuation. It seems not unlikely that the cockroaches in GUNN's (1940) experiments may have lived so long because there was a short cycle variation of about $\pm 0.5^{\circ}$ C. in the constant temperature rooms in which they were kept. These points however are still under investigation. Despite their stimulatory effect, regularly alternating temperature fluctuations do not appear to engender a rhythm in *P. americana* as obtains with *Ptinus tectus* (see above).

It is not yet possible to say whether the absence of rhythm in a normally rhythmic species has a deleterious effect although this point has a bearing upon problems of pest infestation of stored products; and temperature fluctuations may prove to be of much greater ecological importance than is at present realised (See discussion by CHAPMAN, 1931).

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THE RESPIRATION OF THE LARVA OF HELODES MINUTA [Col.]

by

J.E.TREHERNE
Bristol, Great Britain

Introduction

In aquatic insects many specialized habits and structures have been evolved to enable the insects to obtain oxygen from the environment. The more important adaptations include tracheal gills, physical gills of various kinds, and changes in the cuticle to allow diffusion of gases to take place. The respiratory function of the so called blood gills seems to be in doubt (THORPE 1933).

This investigation was made to determine the respiratory significance of the anal papillae and of the abdominal air bubble, which could function as a temporary physical gill. The part played by the general body surface is also described.

Habitat and Description of the Larva.

The larva of the beetle *Helodes minuta* L. is found chiefly in fast flowing streams, where it lives in the less turbulent parts and beneath stones.

The larva is metapneustic, and possesses a number of large tracheal air sacs. By contraction of the abdominal air sacs it is able to force a bubble of air out through the last pair of abdominal spiracles. The bubble is maintained in this position chiefly by means of a number of semi-hydrofuge hairs. The air in the bubble is in free communication with that contained in the tracheal system. The insect periodically renews its air supply by rising to the surface and taking in air through the two abdominal spiracles.

Ventral to the two abdominal spiracles are five finger-like rectractile anal papillae.

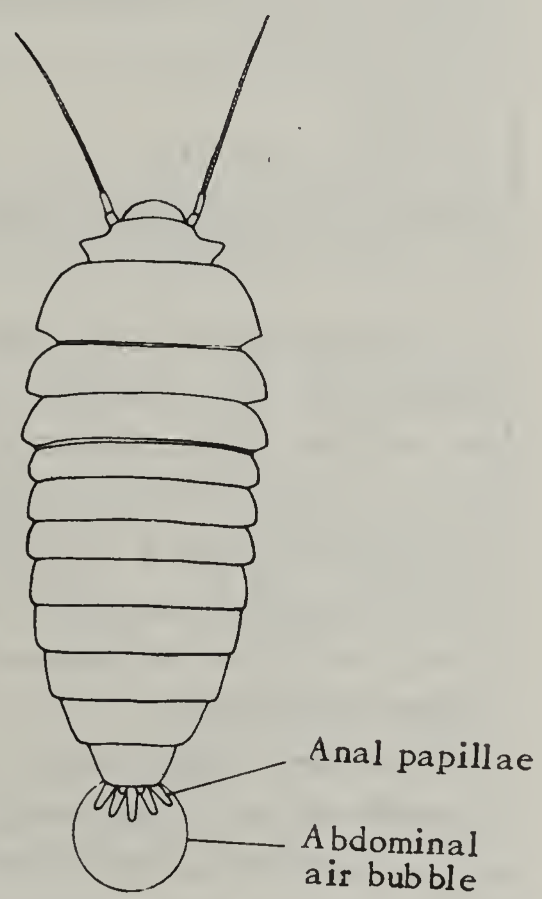

Fig. 1. Larva of *Helodes minuta* (Dorsal view).

Experimental

It was essential to find some way of blocking the anal papillae and spiracles before any experiments could be carried out. The hard cuticle prevented the use of any ligaturing technique. It was found that a small drop of Whitehead's Varnish would prevent protrusion of the anal papillae, and could also be used to block the spiracles. The varnish seemed to have no partic-

ular toxic effects on the larvae.

Survival experiments were carried out to determine whether blocking of the spiracles or papillae influenced the period of survival of submerged larvae. The larvae were submerged in well aerated water by placing them in lengths of glass tubing, which were closed at both ends by pieces of bolting silk. The larvae were thus kept in well aerated water but had no access to atmospheric air. Care was taken to ensure that no bubbles of air were present in the tubes during the experiments. The experiments were carried out at 18° C ($\pm$ 0.5° C).

It was found that larvae kept under these conditions became moribund after a time, and eventually died unless they had access to the surface to renew their air supply. It was easy to see when larvae became moribund: they became quite motionless and assumed a very characteristic posture. It should be noted that this condition did not correspond to the actual death point of the larvae. Observations were made at 15 minute intervals. The results for these experiments are given in Table 1.

Table 1

Type of Larva	No. of Expts.	Variation	Mean.
Normal	9	25.0 - 31.75 hrs	28.5 hrs
Spiracles blocked	9	8.0 - 14.50 hrs	11.25 hrs
Spiracles & papillae blocked	10	8.0 - 14.25 hrs	11.75 hrs

It will be seen from Table 1 that larvae with their abdominal spiracles blocked, and thus unable to form an abdominal air bubble, survived for less than half the time of normal larvae. Larvae with only the spiracles blocked did not survive significantly longer than those with both the spiracles and the papillae blocked ($t = 0.956$; $P = 0.4 > 0.3$). These results indicated that the anal papillae had very little significance as far as respiration was concerned, and that the abdominal air bubble functioned as an important respiratory mechanism.

The next experiments carried out were designed to determine over what range of oxygen concentrations the abdominal air bubble functioned to extract oxygen from the water. In these experiments the rate of oxygen consumption of both normal larvae and those with blocked abdominal spiracles was determined. In each experiment five larvae were placed in a 30 c.c. hypodermic syringe containing tap water. A sample of water was removed from the syringe, and its oxygen concentration determined by the method of FOX & WINGFIELD (1938). The volume of the water in the syringe was then adjusted to 20 c.c., and the syringe was placed in a thermostatically controlled water bath held at a temperature of 20° C ($\pm$ 0.5° C). After six hours a second sample of the water was taken, and the amount of oxygen consumed by the larvae was determined. The oxygen concentration was expressed in c.c. of oxygen consumed per gram of dry tissue per hour.

It was found that the oxygen consumption of normal larvae was about 4.50 c.c./g./hour. This rate of consumption remained steady down to an initial oxygen concentration of about 2.50 c.c./l., after which it fell off rapidly. The oxygen consumption of larvae that were prevented from forming an air bubble fell off at a much higher oxygen concentration (i.e. between 4.50 and 5.50 c.c./l.). This experiment showed that the abdominal air bubble functioned to extract oxygen from water even at relatively high oxygen concentrations. A more detailed account of this section of the work will be published elsewhere.

Experiments were also carried out to investigate the rate of elimination of carbon dioxide from the insect. Larvae which were placed in a suitable pH indicator, in this case Cresol Red, showed a clear colour change around the body surface. This colour change acted as an indicator of CO_2 escape. It was found that the colour change occurred more rapidly around the abdominal air bubble than around the body surface. When the spiracles were blocked, the colour change in the region of the anal papillae was found to be more than that around the general body surface, but not so rapid as that around the abdominal air bubble. The results for these experiments are summarized in Table 2.

Table 2

	No. of Expts.	Mean time for colour change.	σ
Normal larvae			
Body surface	8	5 mins. 8 secs.	± 39 secs.
Air bubble	8	34 secs.	± 8 secs.
Operated larvae			
Body surface	8	4 mins. 34 secs.	± 29 secs.
Anal papillae	8	1 min. 54 secs.	± 15 secs.

The CO_2 is therefore eliminated at a greater rate through the abdominal air bubble than through the body surface. It escapes less rapidly through the anal papillae than through the air bubble, but the rate of elimination through the papillae is more than twice that through the general body surface.

Discussion.

Submerged larvae deprived of the abdominal air bubble, survive for less than half the time of normal larvae. This clearly suggests that the abdominal air bubble functions as an efficient physical gill. It was first demonstrated by EGE that an air store can serve a gill function in separating, by diffusion the oxygen dissolved in the water. One factor that limits the time of survival beneath the surface is the tendency of the nitrogen in the air store to dissolve out, so that the surface area of the air store is continuously being decreased, the physical gill becoming progressively less efficient.

The oxygen consumption experiments showed that the oxygen consumption

of normal larvae does not fall off until an initial oxygen concentration of about 2.50 c.c./l. is reached. The consumption of larvae deprived of the abdominal air bubble falls off at a higher oxygen concentration (i.e. between 4.5 and 5.5 c.c./l.). Thus at relatively low oxygen concentrations the abdominal air bubble plays a very important part in the respiration of the insect.

The larva has no special organs or habits that maintain a flow of water across the surface of the air bubble. This must be due to the fact that it is a fairly active insect, and in moving it is able to keep the surface of the air bubble in contact with well oxygenated water.

Larvae with the last pair of abdominal spiracles blocked survived, in well aerated water, for an average period of 11.25 hours. Those which had both the spiracles and the anal papillae blocked survived for an average period of 11.75 hours. Thus larvae with the anal papillae intact did not survive longer than those which were deprived of the papillae. It therefore seems reasonable to assume that the anal papillae do not play an important part in the respiration of the insect. It might be argued that the anal papillae function only in critical periods, when the larva can extract oxygen from the environment only with difficulty. This does not seem to be possible however, for larvae deprived of the air bubble were, in effect, suffering an oxygen lack, and were thus in a critical respiratory state. Experiments on the anal papillae of larvae of various Diptera (FOX, 1920, WIGGLESWORTH 1933, THORPE 1933) have all demonstrated that these structures do not play an important part in the respiration of the insects.

The elimination of carbon dioxide from the air bubble proceeds at a rate which is about nine times more rapid than that from the body surface. The escape of CO_2 through the anal papillae also occurs more rapidly than through the general body surface.

Acknowledgements

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ATTOGRAFO MULTIPLO PER LO STUDIO DEL COMPORTAMENTO CINETICO DI ARTROPODI

par
Mario PAVAN
Pavia, Italia

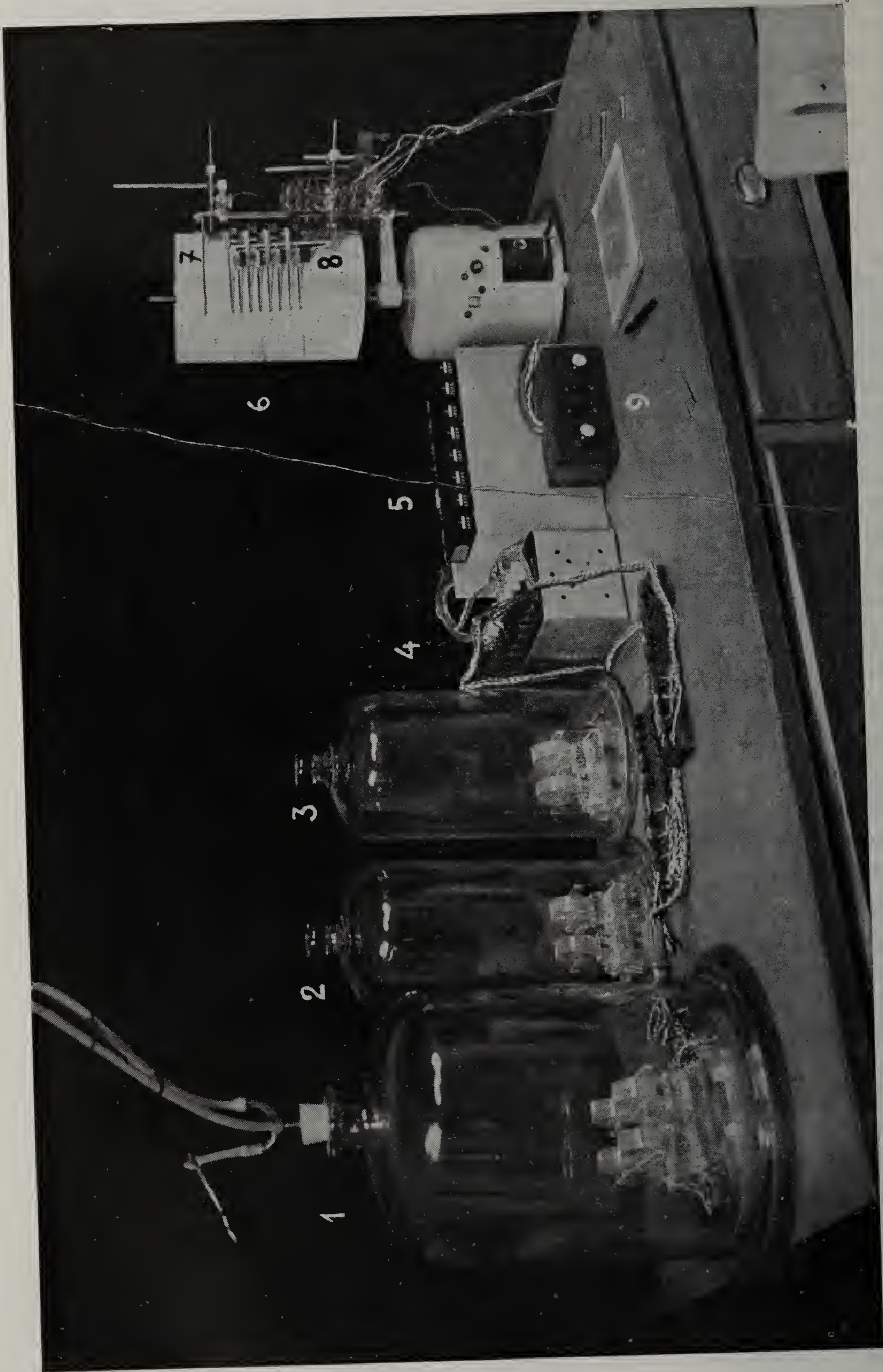
Nello studio del comportamento degli animali una delle più sentite necessità è quella di disporre di apparati che con una registrazione dei fenomeni riducano il più possibile la causa di errore dovuta alla soggettività delle interpretazioni dello sperimentatore. In modo particolare questa necessità è sentita quando si deve studiare il comportamento cinetico il cui studio si è dimostrato molto importante in relazione a molteplici fattori naturali e sperimentali.

Sono a mia conoscenza varie apparecchiature per la registrazione dell'attività degli insetti: ad es. EVERLY (1929), LUTZ (1932), SZYMANSKY (1932), YEAGER e SWAIN (1934), PARK (1935), CHAUVIN (1943, 1944), BRIAN (1947), GHIDINI (1947). GHIDINI (1948) per primo ha realizzato un attografo a camera ruotante.

Finora, a quanto mi consta, questi apparecchi vennero impiegati in esemplari unici per lo studio dell'attività di singoli individui, tranne il caso di CHAUVIN (1943) che registrava il comportamento cinetico globale di un intero piccolo formicaio. Tutte queste apparecchiature registravano, generalmente, le fasi di movimento con la scrittura a sfregamento su carta affumicata applicata al chimografo o con registrazione fotografica di un raggio luminoso deviato dai movimenti dell'attografo (CHAUVIN 1943). L'„entomografo" di YEAGER e SWAIN (1934) registrava l'ampiezza dello spostamento angolare di un indice in dipendenza con l'intensità dello sforzo dell'insetto.

Alcuni di questi apparecchi costringevano a tenere l'insetto legato o comunque fissato ad un supporto in condizioni anormali. Nessuno di questi apparecchi consentiva una valutazione quantitativa dei percorsi effettuati dall'insetto in esperimento, ma solo la registrazione delle fasi di moto e di quiete.

Nello svolgimento del mio programma di studio della fisiologia degli insetti, ho costruito una serie di 8 attografi basati sull'attografo a camera ruotante con sostanziali modifiche e completamenti rispetto a modelli preesistenti. Mi sono attenuto ai seguenti criteri: 1) semplicità di costruzione e funzionamento; 2) impiego contemporaneo di più apparecchi per poter lavorare in condizioni identiche per ogni serie di insetti, e ottenere rapidamente valori statisticamente elaborabili; 3) registrazione grafica delle fasi di attività; 4) registrazione quantitativa dei percorsi effettuati dai singoli insetti; 5) adattabilità degli apparecchi a molteplici tipi di ricerche sperimentali.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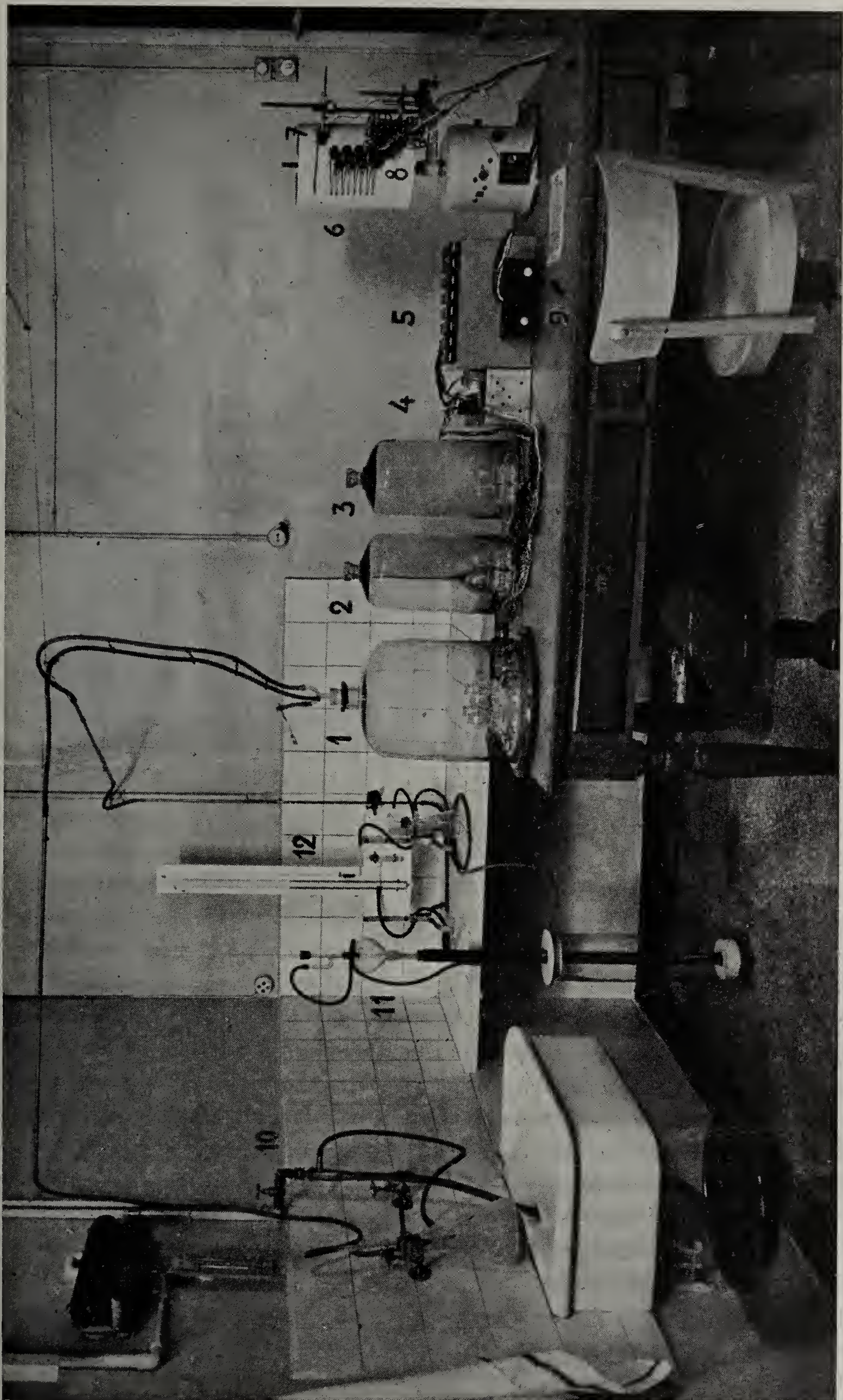

Fig. 2

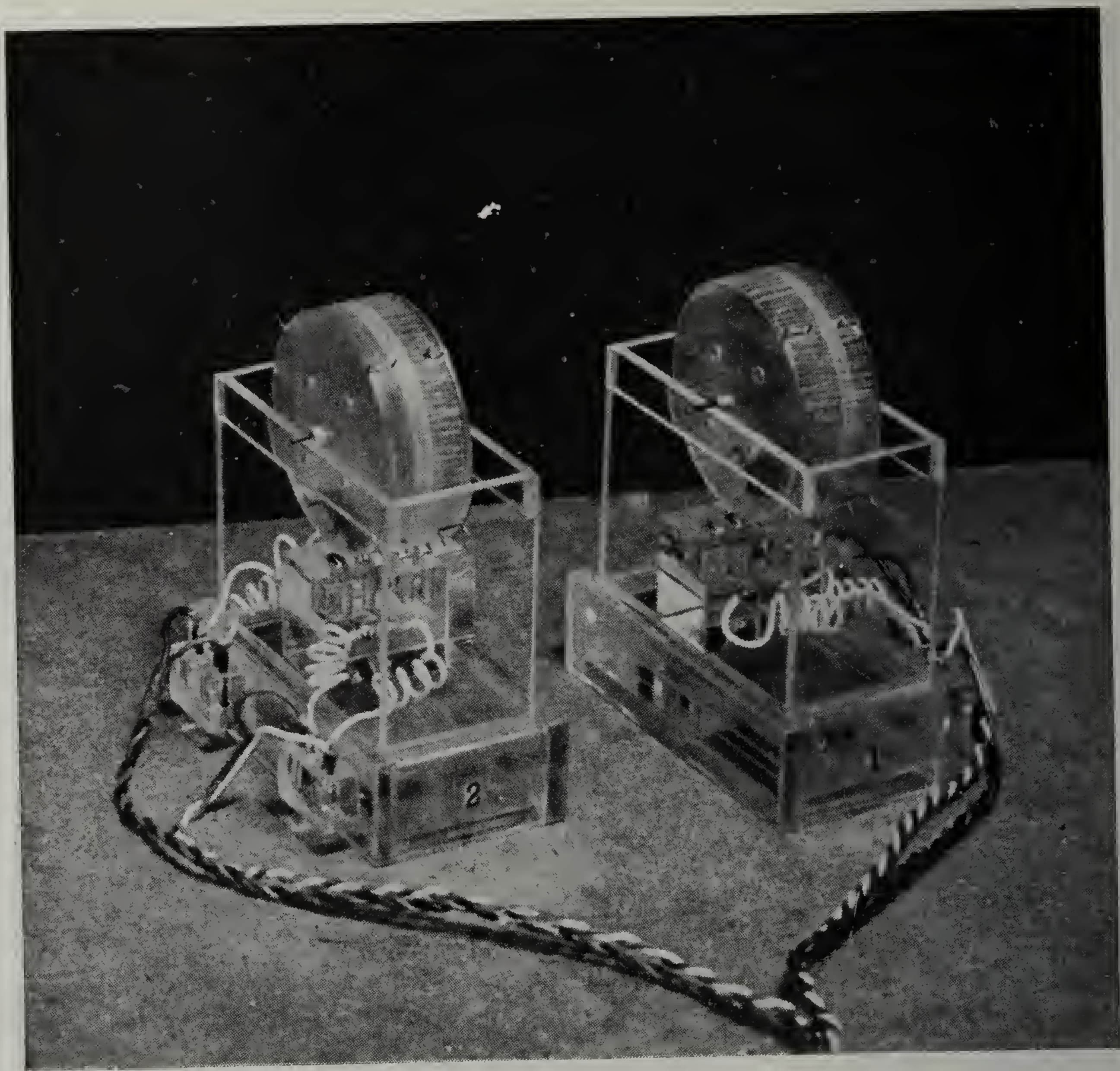

Fig. 3

Perciò gli apparecchi hanno le seguenti caratteristiche: 1a) sono costruiti in plexiglas incolore. Ogni camera ruotante porta perifericamente ponticelli metallici destinati ai contatti elettrici col mercurio che si trova nei piccoli pozzetti sotto alla camera e i cui impulsi passano agli apparecchi di registrazione (v. 3a e 4a). 2a) Gli apparecchi riuniti in piccolo spazio possono funzionare singolarmente a gruppi, o tutti insieme. 3a) La camera è messa in rotazione dai movimenti deambulatori dell'insetto che vi è chiuso nell'interno, e determina i contatti fra i ponti metallici periferici ed il mercurio. Gli impulsi elettrici sono inviati alle penne elettromagnetiche, queste registrano gli impulsi scrivendo con l'inchiostro su carta applicata al tamburo del chimografo. 4a) Ogni impulso elettrico viene contemporaneamente trasmesso ad un contatore elettromagnetico. Conoscendo la circonferenza della camera ruotante, il numero dei contatti ci permette di calcolare il valore in metri dei percorsi effettuati dagli insetti in tempi determinati. 5a) Nella disposizione che presento, quattro apparecchi sono alloggiati sotto campana pneumatica per l'applicazione di condizioni sperimentali particolari e quattro sono per i controlli sotto semplice campana di vetro. Nella campana pneu-

matica si possono determinare condizioni particolari di pressione e depressione, composizioni di gas, luce, temperatura, umidità, odori, suoni, ecc. Nella figura si vede l'impianto funzionante per la depressione, con livellatore di depressione a mercurio.

Gli apparecchi possono ad esempio servire per le ricerche sul comportamento cinetico naturale e sperimentale, per lo studio dell'azione di insetticidi per respirazione e per contatto o di sostanze farmacologiche, per la ricerca del comportamento di insetti sottoposti anche a particolari pretrattamenti e poi introdotti nell'apparecchio, ecc.

Il peso della camera ruotante determina la sensibilità degli attografi. Si può facilmente arrivare a lavorare anche con insetti della mole di un'ape e perfino di operaie di *Formica rufa* L. Il chimografo elettrico che impiego può funzionare con 25 velocità differenti e porta un registratore elettrico dei tempi con scrittura ad inchiostro, regolabile su 2'', 6'', 10'' e 25''.

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DISCUSSION

Mr. **Reali**: Peut on calculer avec les appareils actographes l'intensité des effets qu'on obtient avec l'administration des diverses substances? Jusqu'à ce moment il me semble que non, et c'est ça le défaut de ces appareils.

Mr. **Pavan**: J'ai déjà expliqué que ces appareils donnent l'enregistrement des mouvements déambulatoires avec le tracé des phases et le nombre de mètres parcourus par les insectes. Souvent la locomotion est une expression suffisamment précise du degré d'excitation de l'animal; voici donc les cas dans lesquels les actographes nous donnent un enregistrement dans le sens que vous désirez. Logiquement, si l'animal ne marche pas, mais s'il bouge seulement les pattes ou une partie quelconque du corps, la chambre de l'actographe ne roule pas et l'appareil ne donne pas d'enregistrement. C'est une règle générale qu'il faut choisir soigneusement les insectes par rapport au problème qu'on étudie et à l'appareil qu'on emploie. Dans le cas des actographes il faut aussi contrôler, sans interruption, le comportement des insectes qui se trouvent dans les chambres roulantes (qui sont transparentes), et annoter les détails des réactions qui ne peuvent pas être enregistrés par l'appareil.

Bien sûr, ces actographes n'enregistrent pas plusieurs des aspects des réactions cinétiques non déambulatoires, mais chaque appareil a ses champs d'application et ses limitations et on ne peut pas exiger plus qu'il ne peut donner. Tous les problèmes ont leur solution et il faut les étudier et les résoudre séparément.

Mr. **Gasser**: Comment pouvez vous différencier l'influence des différents insecticides?

Mr. **Pavan**: Souvent les différents insecticides ou même les différentes doses d'un même insecticide provoquent des réactions de locomotion caractéristiques: par conséquent, on enregistrera des tracés (phases d'activité) et des nombres de contacts (parcours en mètres) différents selon les cas. En comparant ces données et ceux des témoins on pourra différencier l'influence des facteurs expérimentaux. J'ai travaillé non seulement avec les insecticides mais aussi avec des variations de pression et de lumière, et j'ai vu que l'enregistrement graphique des réactions cinétiques (phases d'activité) et l'enregistrement numérique des contacts (longueur des parcours) nous donne de bons résultats. Je présenterai dans de prochaines publications les résultats de ces recherches.

Mr. **Cloudsley-Thompson**: Est-ce que vous pouvez donner quelque chose à manger aux insects dans les chambres?

Mr. **Pavan**: Les chambres roulantes ont des trous dans les parois opposées a travers desquels s'établit l'échange des gaz et des pressions et qui nous permettent aussi d'introduire de petites quantités d'aliments liquides ou solides sans interrompre l'expérimentation.

Mr. **Rivnay**: I have seen the apparatus of Prof. GHIDINI. What is the difference between your apparatus and that of GHIDINI?

Mr. **Pavan**: J'ai dit que mon collègue le Prof. GHIDINI a le premier introduit le principe de la chambre roulante en entomologie. L'appareil de GHIDINI a été employé en un exemplaire unique. Il enregistre uniquement les phases d'activité, avec la plume frottante sur le papier noirci à la fumée; il n'a pas de cloche pneumatique pour les différentes conditions expérimentales ni l'appareil pour les dépressions, avec niveleur à mercure.

Dans mes appareils, à part des détails de construction qui sont très différents de ceux de l'actographe de GHIDINI, j'ai introduit le compteur électromagnétique des contacts, ce qui nous permet à chaque instant de l'expériment une évaluation quantitative, en mètres, des parcours effectués par l'insecte.

Je crois que c'est le premier actographe dont dispose l'entomologie qui nous permet une évaluation quantitative en mètres. Les phases d'activité sont enregistrées avec des plumes électromagnétiques à l'encre, ce qui élimine les difficultés inhérentes à l'emploi et à la conservation du papier noirci à la fumée.

Enfin, avec mes appareils, j'ai réalisé la possibilité de travailler simultanément avec 4 actographes dans des conditions expérimentales rigoureusement identiques et avec 4 témoins, ce qui nous permet aussi de parvenir rapidement à des valeurs statistiques.

"IRIDOMYRMECIN" AS INSECTICIDE

by
Mario PAVAN
Pavia, Italy

At the VIII International Congress of Entomology at Stockholm in 1948 and in other publications the Author reported that from *Iridomyrmex humilis* Mayr (Hym. Formic. Dolichoderinae) it has been possible to obtain a pure substance, which he named "iridomyrmecin", having *in vitro* antibacterial properties against gram-negative, gram-positive and acid-resistent germs. Biological, chemical and physical research has been continued in the meantime, showing the insecticide power of the above substance. The Author summarized briefly hereafter the results obtained: the reported data have been in part already published, while the remaining will be published in short in the publications as from the joined bibliography.

Origin of the substance: "Iridomyrmecin" is obtained by the so-called anal glands of femals and worker of *Iridomyrmex humilis* Mayr and *in vivo* it is to be found active in the lipidic part of the venom contained in the secretion reservoir of these glands. This bifid reservoir does not open into the cloacal opening, as many publications report in the case of Dolichoderinae, but dorsally between the two last tergits of the gaster. The newborn worker is free from "iridomyrmecin", which is successively formed pending the pigmentation of the body preceding the exit out of the nest.

The full extraction of "iridomyrmecin" from 20 million workers caught during the summer season with a gaster not filled with food, provided 3,453 gamma for each worker, corresponding to 1% of the body weight.

The raw venom extracted experimentally from living workers of *Iridomyrmex humilis* and applied to workers of the same species causes toxic effects comparable to those caused by the contact of pure "iridomyrmecin". Also on other kinds of insects the treatment with raw venom extracted experimentally from workers of *I. humilis* and the treatment with "iridomyrmecin" by contact produce a symptomatology entirely comparable in both instances.

It has been possible to remark that workers of *I. humilis* use the "iridomyrmecin"-venom for offence and defence against other insects, first of all Formicidae, unloading it on their bodies: it may be presumed that the above proves to be one of the factors of the expansion of this species.

Toxicity of "Iridomyrmecin" against species of insects (3,4,5).

Symptomatology: "Iridomyrmecin"-sensible insects show a symptomatology similar to that caused by DDT poisoning. Usually it developes as follows: precocious initial excitement; paresis of the antennae and the limbs; frequent anomodromic movement of the legs; contortions of the body with short falls or supinations; prolonged supinations with clonic contractions

of body and legs and akinesis. With species having little sensibility the toxic reaction is liable to halt at the initial phases or to regress.

Results of the tests: The Author made comparative tests of action by contact in Petri dishes with DDT-pp', gamma-hexachlorocyclohexane and "iridomyrmecin", using different concentrations, on 15 species of insects. The results are summarized in the following table 1, where the marks o, +, ++, +++ show the different grades of toxicity of each insecticide at the given doses:

Table 1

Species of insects treated	Concentrations in Petri dishes 1 gamma per cm^2			10 gamma per cm^2		
	Irido-myrme-cin	DDT-pp'	gamma HCH	Irido-myrme-cin	DDT-pp'	gamma HCH
DICTYOPTERA, BLATTIDAE:						
Blattella germanica L.	•••	•••	•••	o	o	•••
COLEOPTERA, CARABIDAE:						
Platinus dorsalis Pont.	•••	•••	•••	+	++	•••
STAPHILINIDAE:						
Paederus fuscipes Curt	•••	•••	•••	+++	++	•••
CURCULIONIDAE:						
Calandra granaria L.	•••	•••	•••	++	++	••
DIPTERA, DROSOPHILIDAE:						
Drosophila virilis Str.	•••	•••	•••	+	++	••
Drosophila funebris Fabr.	•••	•••	•••	++	+++	••
MUSCIDAE:						
Musca domestica L.	•••	•••	•••	+++	+++	••
Musca domestica L. DDT-resistant (o)	•••	•••	•••	+++	o	••
CULICIDAE:						
Anopheles maculipennis Meig. v. *atroparvus* Van Thiel (♀♀)	+++	•••	+++	•••	•••	••
HYMENOPTERA, FORMICIDAE:						
Formica rufa L. *pratensis* Retz. ☿☿	++	o	+++	+++	++	++
Lasius bicornis affinis Sch. ☿☿	•••	•••	•••	+++	o	++
Lasius brunneus Latr. ☿☿	•••	•••	•••	++	o	++
Dendrolasius fuliginosus Latr. ☿☿	•••	•••	•••	+++	+	••
Iridomyrmex humilis Mayr ☿☿	+++	+	+++	+++	+	+
HETEROPTERA, PYRROCHORIDAE:						
Pyrrochoris apterus L.	•••	•••	•••	++	o	•••

(o) Resistant per 24 hours to contact with 10.000 gamma of DDT-pp' pe[r] cm^2.

By means of the revolving chamber actograph the Author registered also the toxicity reaction of DDT-pp', gamma-hexachlorocyclohexane, "iridomyrmecin" on workers of *Formica rufa pratensis* Retz.: the above tests proved that at 10 gamma per square centimeter the action of "iridomyrmecin" and of gamma-hexachlorocylclohexane are practically equivalent, while DDT-pp' causes the end of the activity in twice the time. At a dose of 1 gamma per sq/cm the action of gamma-hexachlorocylclohexane is quicker than that of "iridomyrmecin", while DDT-pp' gives no reactions, showing any toxicity. At a dose of 1 gamma per square centimeter the action of "iridomyrmecin" compares with a tenfold concentration of DDT-pp'.

Toxical action within given limits of time: Lasius affinis Sch. and *Dendrolasius fuliginosus* Latr. (Formic.) at 1 minute exposure at 10 gamma of "iridomyrmecin" per 1 sq.cm show reactions of toxicity of some importance (up to supinations) lasting in some cases as long as 6 hours, whereas a comparable concentration of DDT-pp' at the same time of exposure does not cause any reaction.

Toxicity for warmblooded animals (1, 4, 6): In the case of the white mouse both by oral (DL 50: 1,5 g/Kg) or by endoperitoneal way in oil solution (DL 50: 1 g/Kg) the toxicity is quite low. A table on the toxicity of "iridomyrmecin" is reported hereafter compared with 3 of the most well-known insecticides, based on the treatment of the white mouse by gastric way.

Table 2

DL 50 for the white mouse by gastric way in mg of weight per kilo of the animal's weight

Iridomyrmecin	DDT-pp'	gamma-hexachlorocyclohexane	Parathion (Xanthion, E 605)
1500	225 (x)	225 (x) 190 (x)	12,5 (x)

(x) Data from the chemical literature.

Diffusion and permanency in the organs of homeotherms: In the white mouse the substance injected endoperitoneally in oily solutions at 4% or in hydroalcoholic solution at 2% at a rate of 0,25 grams per kilo is traceable in the liver, the lungs, the kidney, the spleen, the brains, the blood, in which by means of a biological test based on its insecticide properties it is found at least until two hours after the injection. The permanency is less with the oil solution. "Iridomyrmecin" solved in serum, in citrated guinea-pig blood, in urine of rats, is entirely recoverable and keeps unaltered its chemical and biological properties at least for some hours.

The Author wishes to mention that the presence of defibrinated blood and of serum in cultures on agar of an haemolytic strain of Staphylococcus aureus

does not alter the antibacterial activity of the substance.

Chemical and physical properties: All data gathered and published by the Author show that it appears to be a natural product, so far unknown by the chemical literature, having the following formula:

$$C_{10}H_{16}O_2$$

Molecular Weight	168
Initial melting point	58° - 59° C
Melting point	60° - 61° C

It is soluble at room temperature in H_2O at about 2% and soluble also in the common organical solvents (aethyl ether, petroleum ether, aethyl alcohol, methyl alcohol, acetone, benzol, xylol, chloroform, etc.). It is colourless, having a light aromatic flavour and a light saline taste. It keeps for 30' at 120° C; at -15° C for months. In closed glass containers at room temperature it keeps unaltered for years (1948/1951) without losing anything of its activity (4).

Since the Author has not had the possibility to develop further research on chemical and physical properties of "iridomyrmecin", this product is now being investigated by Prof. R. FUSCO, Director of the Research Center for Insecticides of the Montecatini Co. at the Industrial Chemistry Institute of the University of Milan and by Prof. VERCELLONE, Director of the Scientific Laboratory of the Farmitalia S.A., who in fact gave some data mentioned hereafter:

It appears to be a lacton having the following group $-CO-O-CH_2-$ rotatory power $[\alpha]_D^{20} = 210°$ (c = 4 aethyl alcohol); refractive index $n_D^{65} = 1{,}4607$. Soluble in caustic alkalis and precipitated again unaltered by mineral acids.

Transformable by alkaline alcoholates into an isomer product with antibacterial properties *in vitro* and also insecticide properties, having the following characteristics: melting point 55° C, rotatory power $[\alpha]_D^{20} = 52{,}5°$ (c = 4 aethyl alcohol).

From chemical research it is to be deducted that "iridomyrmecin" is structurally close to another natural product which is already known.

Conclusions

"Iridomyrmecin" appears to be a material worth to be investigated also on account of the simultaneous presence of antibacterial and insecticide activities in the same molecule, of its low toxicity on homeotherms, of the simultaneous watersolubility and liposolubility in relation to the waxy and aquous layers of the tegument of insects and to the existence of lipidic capsules covering some species of pathogen bacteria.

It appears therefore reasonable that the studies being carried on at present for the analysis and the synthesis of this substance be continued in view to discover and exploit its active functional groups.

In the field of researches of insecticides and antibacterial substance from animal source "iridomyrmecin" is actually, as far as I know, the firs

antibiotic and insecticide substance obtained at the pure crystalline status, and it is as well the first pure crystalline substance which is recognized having at the same time insecticide and antibacterial properties. With regard to the insecticide activity a new chapter on insecticides of animal origin is opened: this is a promising program, which in fact has been started already. So it has been possible to extract from other Dolichoderinae (*Tapinoma, Liometopum*), of which the offensive action of their poisons against other insects was already generically known, raw materials having insecticide properties quite different from "iridomyrmecin" and having as well antibacterial properties.

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See in 1), 2) or 4) the complete list.

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DISCUSSION

Mr. **Le Masne**: M. PAVAN peut-il m'indiquer dans quelles fourmis, autres que de Dolichoderinae, il a recherché des antibiotiques? Il a obtenu, je crois, plusieurs résultats négatifs. Ceux-ci, bien entendu, n'ont pas d'intérêt pratique. Mais ils ont un grand intérêt du point de vue physiologie comparée, et du point de vue myrmécologie comparée.

Mr. **Pavan**: Je suis d'accord avec M. LE MASNE que tous les résultats, même négatifs, issus des recherches sur les antibiotiques des fourmis, présentent un intérêt pour la myrmécologie comparée et aussi pour la physiologie des insectes.

J'ai étudié jusqu'a présent 10 espèces de fourmis appartenant à differentes subfamilles, c. à d. les espèces suivantes:

Myrmecinae: *Crematogaster scutellaris* Oliv.

Camponotinae: *Formica rufa pratensis* Retz., *Dendrolasius fuliginosus* Latr., *Lasius niger* Latr., *L. alienus* Foerst, *L. niger x alienus*, *L. bicornis affinis* Sch.

Dolichoderinae: *Iridomyrmex humilis* Mayr, *Liometopum microcephalum* Panz., *Tapinoma nigerrimum* Nyl.

En général les espèces qui produisent de l'acide formique (Myrmecinae, Camponotinae), m'ont donné des résultats positifs contre les differentes bac-

téries, et dans quelques cas il m'a été possible de contrôler que l'action antibactérienne est due uniquement à cet acide (*Formica rufa pratensis*) tandis que *Dendrolasius fuliginosus* et *Lasius bicornis affinis* produisent une autre substance antibactérienne par des glandes situées dans la tête et dont je poursuis l'étude sous différents points de vue. Les larves que j'ai etudiées parallèlement avec les adultes de certaines espèces (*Dendrolasius fuliginosus, Lasius niger, L. alienus, L. bicornis affinis*) ont donné des résultats toujours négatifs. On ne peut pas exclure qu'avec des techniques d'étude différentes on puisse obtenir des résultats différents. J'ai comparé naturellement les Fourmis à acide formique avec les Dolichoderinae qui n'en produisent pas et j'ai obtenu des résultats intéressants: le Dolichoderinae *Iridomyrmex humilis* produit une seule substance antibactérienne, l'iridomyrmécine, *Liometopum microcephalum* et *Tapinoma nigerrimum* produisent des substances antibactériennes dont la nature m'échappe encore: vu les caractères que j'ai observés je crois que ces substances sont différentes de l'iridomyrmécine. Les extraits des deux espèces de *Liometopum* et *Tapinoma* ont aussi un pouvoir insecticide. D'autre part les espèces de Myrmecinae et de Camponotinae que j'ai étudiées ne produisent pas d'iridomyrmécine. Je pense que soit pour l'acide formique, soit pour les substances des espèces de Dolichoderinae, un rôle important à l'état naturel est celui de leur activité insecticide, et que l'activité antibactérienne est une propriété secondaire. Il faut remarquer que l'acide formique et les substances des venins des Dolichoderinae sont toxiques par contact même sur les espèces qui les produisent et que ces substances toxiques ne se trouvent pas en circulation dans l'insecte mais seulement dans des glandes et dans un reservoir special duquel elles sont destinées à l'expulsion. On ne peut pas imputer à ces substances antibactériennes une prétendue immunité ou résistance des Fourmis aux maladies infectieuses. Mais il faudra étudier encore beaucoup avant de parvenir a des résultats soit plus détaillés soit plus généraux. C'est la le but de mes recherches.

Mr. **Rivnay**: How practical is the mass collecting and mass extraction of the substance?

Mr. **Pavan**: Avec des pièges et des appâts attractifs on peut récolter en nature de grandes quantités d'ouvrières de *Iridomyrmex humilis*; j'en ai extrait d'un seul olivier trois millions. La quantité de iridomyrmécine qu'on peut extraire est de 1% du poids des animaux, ce qui représente un pourcentage industriel, quand on pense que, par exemple, on extrait des fleurs de Pyrethrum cinerariaefolium L. 0,5 - 1% de pyréthrines.

Mr. **Van Thiel**: Avez-vous observé une action remanente (residual effect) de la substance isolée par vous?

Mr. **Pavan**: Je regrette de n'avoir pas de données sur la persistance de la substance: je peux remarquer seulement qu'elle est stable et très résistante aux facteurs climatiques comme je l'ai déjà relaté dans la communication que je viens de faire.

Mr. **Perry**: I think Dr. PAVAN should be congratulated on his apparent

success in recovering from Arthropods a biologically active substance particularly against bacteria and, as he has demonstrated, against insects. If this substance proves to be as effective as he indicates in his present talk, then this surely will open a new field in investigations in physiology and biochemistry of Arthropods. It is not unreasonable to assume that such a phenomenon exists in Arthropods for we are demonstrating every day the effect of biologically active substances from humans. It remains to be seen, however, whether future investigators can duplicate the work which PAVAN has reported here today. I have two questions to ask Dr. PAVAN: 1. How does he account for the seasonal variation in the output of iridomirmecin by these individual species; 2. is there any hormonal control in the elaboration of this substance?

Mr. **Pavan**: I should like to thank Dr. PERRY very much for his appreciation of the results of my investigations. I may now add that my researches have been confirmed in a recent work by GHIDINI (1951). I do not yet know if there are in fact seasonal variations in the production of iridomyrmecin. I have observed that cocoons and emerging workers do not contain this substance. The production of this substance occurs only when a worker has a pigmented body and is able to leave the nest. This conforms with a rule which seems to have general value and which I have found valid for several species of Formicidae and other Hymenoptera.

I think that also in the case of iridomyrmecin, as happens with many secretion and excretion products, it is possible to find variations in accordance with feeding or other biological and environmental factors, but I have no definite data because I have not yet investigated this subject. Similarly I have not yet studied a possible hormonic control in the elaboration of iridomyrmecin.

L'EMPLOI DU BLEU DE METHYLENE DANS L'ETUDE DE L'INNERVATION ET DES ORGANES SENSORIELS DES INSECTES

par
G. RICHARD
Paris, France

Au cours des expériences sur les Tropismes des Insectes que j'ai entreprises dans le Laboratoire de mon Maître, M. le Professeur Pierre P. GRASSÉ, j'ai eu très souvent besoin de connaître avec présision l'anatomie sensori-nerveuse des Insectes étudiés. Cette connaissance est indispensable pour différencier les divers récepteurs sensoriels, ainsi que pour pratiquer toutes les ablations ou sections de nerfs.

Après un certain nombre d'auteurs, il me semble que la meilleure méthode de recherche des nerfs et de leurs terminaisons est la coloration supra-vitale au bleu de méthylène. Elle présente de grands avantages: son emploi est très simple; la coloration est parfaitement élective; enfin et surtout, cette méthode permet de colorer les nerfs *in toto*, ce qui rend particulièrement facile la réconstitution de leurs trajets par rapport aux autres organes.

Ce sont quelques résultats que je voudrais donner ici. Ces résultats ont été obtenus avec deux Insectes: le Termite *Calotermes flavicollis* Fab. et le Fourmilion *Acanthaclisis baeticus* Rb.

Le bleu de méthylène employé le plus souvent est celui de GURR. Celui de GEIGY m'a donné des résultats inconstants, alors que le bleu de GRÜBLER me permettait de colorer les nerfs des Termites mais pas ceux des Fourmilions.

J'utilise une solution à 1% dans de l'eau physiologique. Je l'injecte dans le vaisseau dorsal de l'Insecte vivant à l'aide d'une très fine aiguille de verre. Après un temps de repos compris entre 1 et 4 heures, la coloration est fixée dans un bain de molybdate d'ammonium à 10%, le tout étant maintenu pendant 12 heures à la glacière. Pour les Termites, dont les téguments sont suffisamment perméables, la fixation pratiquée ainsi est suffisante. Par contre pour les Fourmilions, dont la cuticule est plus épaisse, il est bon, d'injecter un peu de molybdate dans le corps déjà avant de placer l'Insecte dans le bain décrit plus haut.

La déshydratation, très rapide, obtenue par action directe de l'alcool absolu, s'opère après un abondant lavage à l'eau courante (2 heures au moins). Les préparations sont passées dans le toluène puis montées au Baume du Canada, dans lequel elles se conservent plusieurs années.

Les quelques photographies de colorations dans des pattes de larve de Fourmilion montrent que la précision topographique est très grande; les reconstitutions des trajets nerveux sont faciles. En général, pour chaque

appendice, le ganglion nerveux correspondant donne naissance à deux nerfs d'inégale importance. Le plus petit innerve au plus les deux ou trois premiers articles de l'appendice. Le plus gros innerve l'appendice jusqu'à son extrémité distale; d'ordinaire, il se dichotomise lors de sa pénétration dans chacun des articles.

Cependant, malgré l'intérêt évident de cette étude topographique, la coloration par le bleu de méthylène ne serait pas parfaite si elle ne permettait de faire un travail plus précis au niveau des terminaisons.

Or, la coloration distingue nettement entre les 2 types physiologiques : terminaisons motrices et terminaisons sensorielles. Les fibres motrices et les fibres sensorielles voisinent dans un même nerf, mais entre le ganglion et la terminaison motrice, on ne trouve aucune cellule nerveuse, alors qu'entre le ganglion et la terminaison sensorielle, il y a toujours une cellule nerveuse, située en général à la base de la sensille.

Sous l'uniformité du type, j'ai pu reconnaître trois sortes de terminaisons sensorielles (Termites):

1. les terminaisons dans les sensilla trichodea, basiconica, campaniformia, relativement courtes, épaissies, souvent en tire-bouchon. Dans les sensilla trichodea des Termites, l'extrémité du filet nerveux pénètre dans la cavité de la soie. Chez les Fourmilions, il ne paraît pas en être de même et l'extrémité du filet nerveux semble s'arrêter à la base de la soie. Je ne sais si cette différence morphologique cache une différence physiologique, mais je ne le crois pas. Malgré une étude assez détaillée, je n'ai pas réussi à mettre en évidence des différences entre les terminaisons de ce type. Pourtant les fonctions des sensilla trichodea, basiconica ou campaniformia ne sont certainement pas les mêmes.

2. les terminaisons dans les complexes scolopaux sont bien plus longues que les précedentes et elles sont toujours rectilignes. Les cellules nerveuses de ces complexes sont toujours groupées près du nerf dont elles sont issues, Les terminaisons pénètrent chacune dans un clou scolopal, mais ceux-ci sont rarement visibles, car ils ne se colorent pas sous l'action du bleu de méthylène. En tout cas, la terminaison nerveuse dans un complexe scolopal est toujours reconnaissable au premier coup d'oeil.

3. enfin, au voisinage des articulations, dans les pattes ou dans les pièces buccales, on reconnaît très souvent des terminaisons sensorielles en bouquet à partir d'une cellule nerveuse multipolaire. Ces terminaisons se perdent dans la cuticule.

Lors des mues ces terminaisons sensorielles se colorent encore par le bleu de méthylène et j'ai pu voir, dans une étude préliminaire que le nerf se coupe distalement par rapport à la cellule nerveuse bipolaire. J'ai actuellement en cours une série de colorations destinées à préciser ce phénomène et les résultats feront l'objet d'une prochaine note de ma part.

En résumé, la coloration supra-vitale par le bleu de méthylène est susceptible de rendre les plus grands services aux physiologistes qui étudient le comportement sensoriel des Insectes; j'espère avoir montré qu'elle n'est pas non plus à dédaigner par les morphologistes.

RELATIONS ENTRE L'ETAT PHYSIOLOGIQUE DE LA PLANTE-HOTE, SOLANUM TUBEROSUM ET LA FECONDITE DU DORYPHORE, LEPTINOTARSA DECEMLINEATA SAY

par

P.A.GRISON

Versailles, France

La variabilité de la fécondité du Doryphore en fonction de la nature botanique de l'aliment offert aux imagos a été mise en évidence par TROUVELOT et collaborateurs (1935, 1936, 1937).

Avec une même variété de Solanum tuberosum la ponte des femelles de *L. decemlineata* est plus ou moins grande suivant l'état du développement végétatif de la plante dont se nourrissent les insectes (GRISON 1944).

Le test biologique de laboratoire est effectué en isolant un couple sur un rameau de Pomme de terre placé dans un petit tube d'eau au milieu d'un godet de terre de 8 cm de diamètre, et recouvert d'une bonnette de toile métallique de 10 cm de hauteur.

Au cours de l'expérience la comparaison des quantités d'aliment ingéré par les individus des divers lots permet de nous rendre compte de l'homogénéité relative de l'alimentation du point de vue quantitatif.

Enfin des échantillons de plante sont prélevés afin d'être soumis à l'analyse chimique.

1. Influence de l'heure du prélèvement du rameau nutritif

La teneur du feuillage en certains constituants dépend du rythme quotidien d'activité métabolique du végétal; par conséquent des rameaux prélevés à des heures différentes de la journée n'ont pas la même composition chimique et doivent être *qualitativement différents* pour les insectes qui s'en nourrissent. (DE JONG, 1937).

Nous avons comparé la fécondité de Doryphores nourris avec des rameaux de Pomme de terre, variété „Ackersegen", prélevés à 9 heures et à 18 heures – au début de juin 1948 puis en fin juin 1949 (Tableau I).

Le contrôle préalable de fécondité et le contrôle de l'alimentation établissent l'homogénéité approximative des lots. Bien que les chiffres de fécondité moyenne pour chacun de ceux-ci soient fort différents d'une année à l'autre, la variation reste dans le même sens: *la fécondité des Doryphores diminue lorsque les insectes sont alimentés avec du feuillage prélevé le soir.*

L'examen des résultats de l'analyse chimique (Tableau II) peut donner une indication sur le déterminisme du phénomène et fournir une explication des variations enregistrées entre les séries de 1948 et celles de 1949; en effet les plantes de la première série étaient âgées de six semaines, tandis que celles de la seconde de quatre semaines seulement.

TABLEAU I

Fécondité de *L. decemlineata* en fonction de l'heure du prélèvement du rameau (exprimée en moyenne par femelle et par jour)

Prélèvement	Fécondité moyenne		Consommation moyenne par ♀ et par jour
	par ♀ féconde:	par ♀ & par jour	
à 9 h en 1948	55 oeufs	2,54 oeufs	47,4 mm^2
à 18 h en 1948	29 oeufs	0.41 oeufs	52,7 mm^2
à 9 h en 1949	252 oeufs	13.20 oeufs	110.3 mm^2
à 18 h en 1949	64 oeufs	3.62 oeufs	86.4 mm^2

TABLEAU II

Variation de composition chimique du feuillage de Pomme de terre (série 1949)

	Feuilles Jeunes		Feuilles Vieilles	
en % de matières sèches	9 h	18 h	9 h	18 h
Sucres réducteurs libres	*0.03*	*0.88*	*1.13*	2.08
Saccharose (Sucres réducteurs après hydrolyse)	3.32	3.72	3.37	3.37
Amidon	1.05	0.97	1.06	0.91
Glucides totaux	4.40	5.57	5.56	6.36
Azote total	5.30	5.50	4.10	4.70
Rapport $\frac{\text{Azote}}{\text{Glucides}}$	1.20	0.98	0.73	0.73

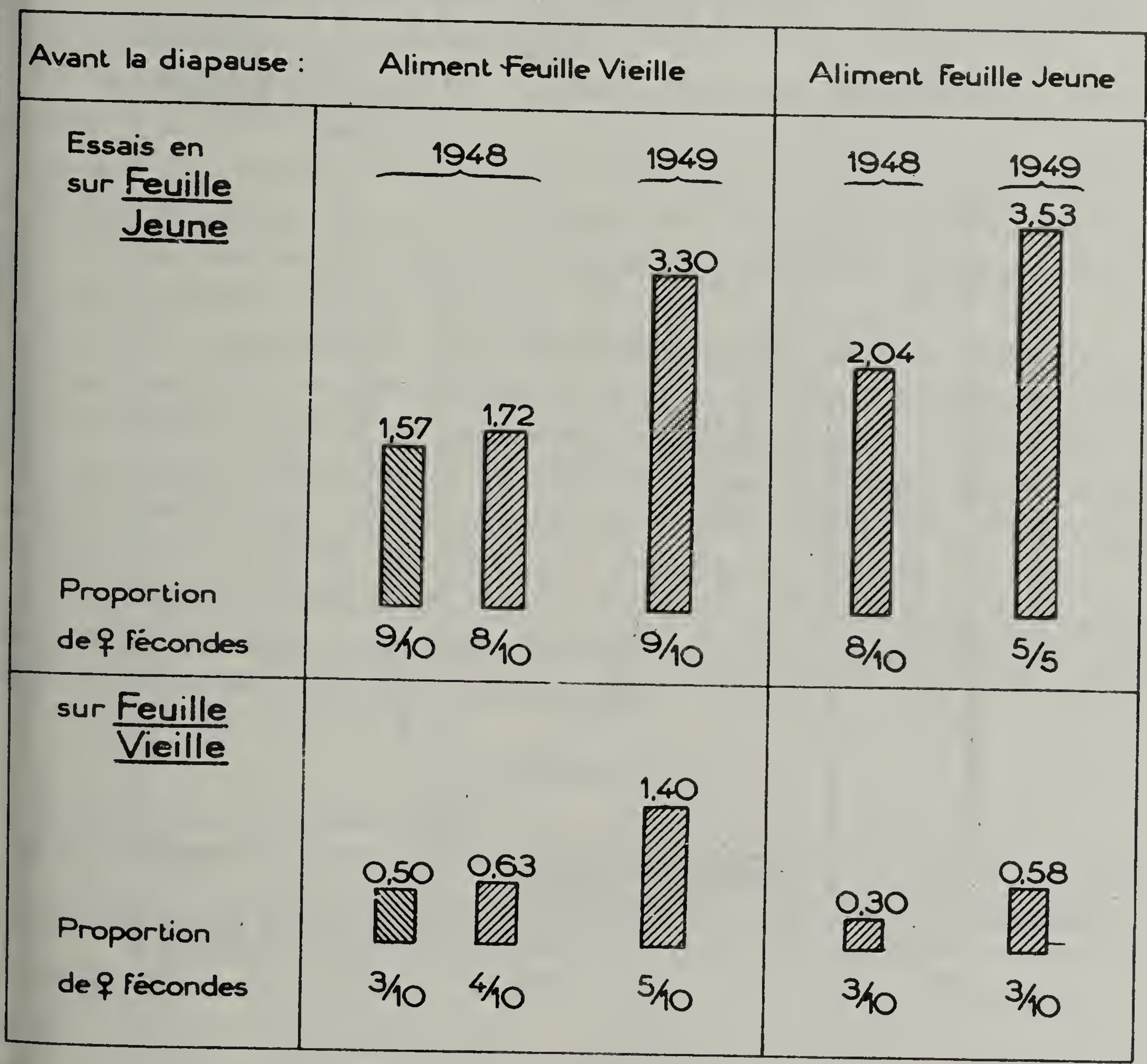
Tableau II met clairement en évidence le fait bien connu que l'élément dont la teneur varie le plus considérablement entre 9 et 18 heures est le glucose. Il est donc vraisemblable que celui-ci intervient dans la limitation de la fécondité chez le Doryphore (Tableau III).

TABLEAU III

Prélèvement	Fécondité moyenne	Glucose %
à 9 h en 1949	13.30	0.03
à 18 h en 1949	3.62	0.88
à 9 h en 1948	2.52	0.34
à 18 h en 1948	0.41	2.18

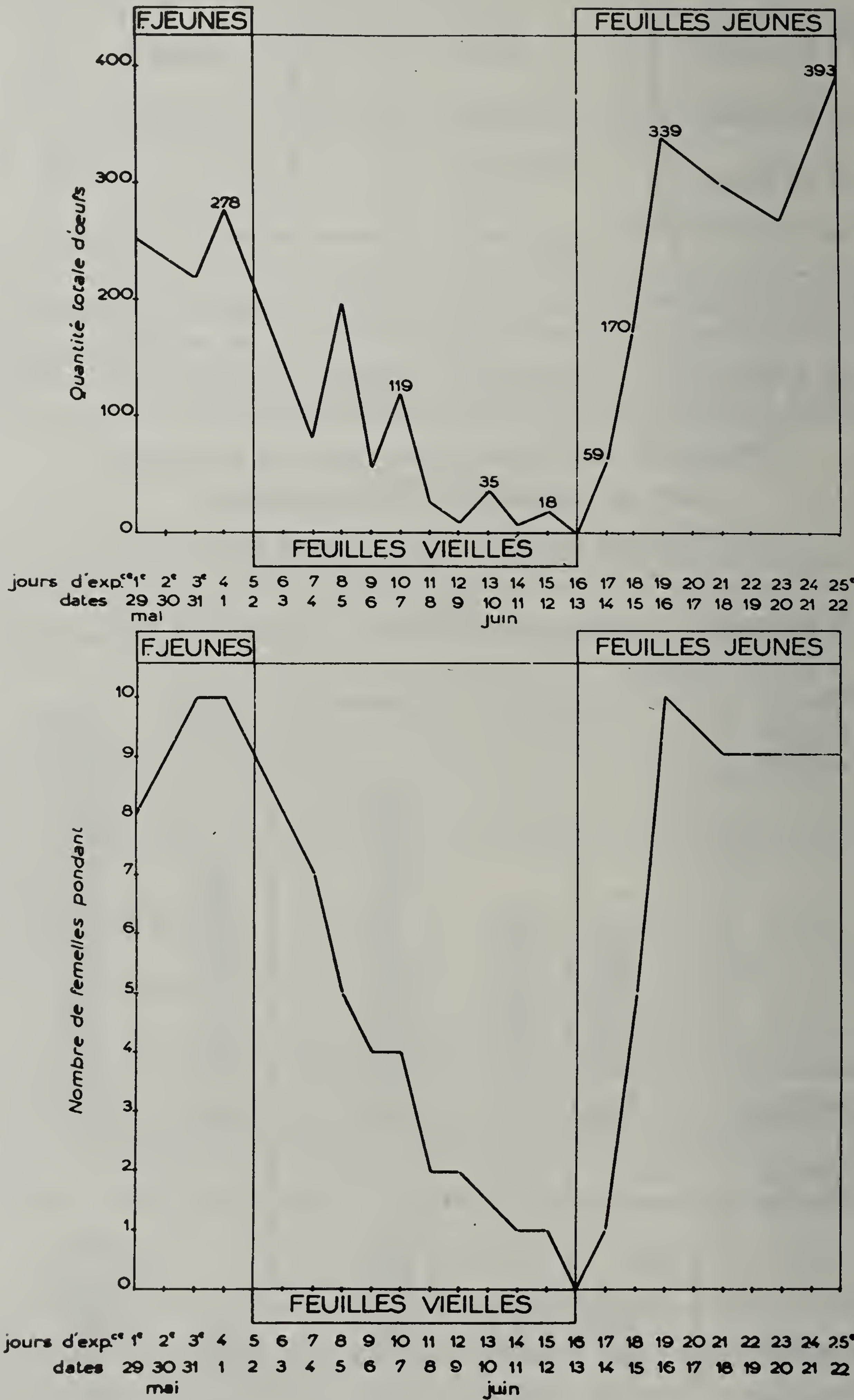
Les tests biologiques, dans lesquels l'aliment est constitué par des feuilles vieilles de Pommes de terre supplémentées avec une solution de glucose, permettent d'enregistrer une fécondité moyenne du Doryphore inférieure à celle obtenue avec aliment feuille jeune (voir Tableau V).

INFLUENCE DU STADE VEGETATIF DE L'ALIMENT
SUR LA FECONDITE DU DORYPHORE
(La fécondité est exprimée par femelle et par jour)



Graphique 1

Dans le cas où la feuille est supplémentée avec de l'amidon il n'y a pas de modification appréciable du taux fécondité. Ce résultat biologique s'accorde avec les données de l'analyse chimique qui ne montrent pas de grandes variations dans la teneur en amidon des feuilles de Pomme de terre utilisées dans nos expériences.



Graphique 2

2. *Influence de l'âge des feuilles ou du stade de développement végétatif de la plante-hôte*

Nous avons déjà montré (GRISON, 1944) l'effet d'une alimentation composée de feuilles sénescentes ou de rameaux prélevés sur des plantes âgées de Pomme de terre sur la fécondité de *L.decemlineata:* la ponte des insectes est considérablement réduite et souvent même l'ovogénèse est inhibée. Le graphique No 1 indique les résultats obtenus dans cinq séries de tests en 1948 et en 1949. Il fait ressortir le fait essentiel que la nature de l'aliment offert aux femelles avant la diapause n'a aucune influence sur la fécondité ultérieure des Doryphores au moment de leur reprise d'activité et de leur période reproductrice.

Une expérience très significative à cet égard vient d'être réalisée: elle consiste à contrôler la fécondité de 10 femelles sur feuille jeune puis de modifier la nourriture de celles-ci en leur offrant des feuilles de même niveau (4e à 6e noeud en partant du bourgeon terminal) mais prélevées sur des plantes plus âgées de cinq semaines. On constate alors que la moitié des femelles cessent de pondre dans les 72 heures et que la ponte s'arrête complètement chez toutes les femelles 11 jours après le changement d'aliment. A ce moment on donne à nouveau du feuillage jeune à consommer aux individus survivants; ceux-ci se remettent presque immédiatement à pondre et le taux de fécondité atteint ou dépasse celui du début de l'expérience ainsi que l'indique le graphique No. 2.

La valeur qualitative de la nutrition a donc un effet immédiat sur la fécondité de L. decemlineata.

Nous avons montré précédemment que la teneur en glucose est un des éléments qui conditionnent la fécondité. Les résultats de l'analyse chimique accusent une augmentation de teneur en glucose des feuilles au fur et à mesure du vieillissement de celles-ci.

Mais nous avons pensé que d'autres éléments pouvaient intervenir et notamment ceux qui sont une manifestation caractéristique du métabolisme des tissus végétaux en voie de croissance, indépendamment des modifications dues au rhythme quotidien de la fonction chlorophyllienne. Parmi ces éléments, notre attention a été retenue par les lécithines que DUCET (1949) avait étudié au cours de la croissance de quelques végétaux.

Les dosages de choline lipidique qui ont été effectués chez la Pomme de terre enregistrent les variations suivantes exprimées en milligrammes de choline totale par gramme de matière fraîche:

TABLEAU IV

Date du prélèvement	Variétés	Feuilles jeunes terminales	Feuilles vieilles de base
25 juillet 1947	Bintje	0.368	0.146
26 juin 1947	Ackersegen	0.245	0.156

Les tests biologiques réalisés avec feuilles supplémentées confirment *le rôle stimulant des lécithines indépendamment de l'effet du glucose* puisqu'il permet même de corriger l'effet dépressif d'un excès de glucose dans une feuille vieille:

TABLEAU V

Tests biologiques de Fécondité chez *Leptinotarsa decemlineata*

	Quant. ♀	Longév. moy. ♀	Quant. ♀ fécond.	Ponte totale	Féc.moy par ♀	Féc.moy ♀/jour
Feuilles Jeunes	5	39 J.	5	697OE	139 OE	3.53 OE
Feuilles Vieilles	10	20	3	122	12	0.58
F.V. + lécithine 2%	9	49	9	2.056	228	5.73
F.V. + amidon 5%	10	28	10	885	88	3.17
F.V. + glucose 10%	9	19	6	257	28	1.51

Dans ces tests, nous avons procédé à des évaluations approximatives de la quantité d'aliment consommé par chaque femelle, qui ne nous permettent pas de fixer d'une manière absolue les valeurs de la consommation dans les différents cas, mais qui nous ont paru suffisantes pour en indiquer les valeurs relatives. Celles-ci, exprimées en mm^2 par femelle et par jour, et dans les trois cas de feuilles vieilles supplémentées, sont respectivement de: 85, 84 et 64.

Nous ne pouvons nous prononcer dans l'état actuel de nos recherches, sur la nature de la fraction lécithinique active et notamment sur le rôle éventuel du phosphore organique. Par contre certains tests nous permettent de penser que la choline libre, ou vitamine J des Vertébrés, n'aurait pas d'effet sur la fécondité du Doryphore.

En conclusion la fécondité de *L.decemlineata* peut dépendre à la fois d'un équilibre entre constituants plastiques (rapport C/N), d'une teneur optimum peu élevée de certain constituant (le glucose) et de la présence d'éléments de stimulation (les lécithines) dans la plante-hôte.

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DISCUSSION

Mr. **Bounhiol**: M.GRISON, pense-t-il que: L'action du glucose est une action hibitrice sur la fécondité comme il semble ressortir des données numéries fournies? Ou bien puisque la lécithine est en quantité peu différente atin et soir: le glucose ne gêne-t-il pas quand il est en excès, l'utilisation r l'animal de la lécithine ou d'autres produits insoupçonnés.

Mr. **Grison**: La deuxième hypothèse nous paraît être plus probable; mais s résultats obtenus jusqu'à présent nous semblent encore insuffisants pour avancer. Nous désirons poursuivre notre expérimentation dans ce sens.

THE EFFECTS OF DIPHTHERIA TOXIN ON THE CECROPIA SILKWORM (Platysamia cecropia) *)

by

A. M. PAPPENHEIMER Jr and Carroll M. WILLIAMS

New York (N.Y.), U.S.A.

Studies on the metabolism of the diphtheria bacillus have provided ev dence that the potent toxin elaborated by this organism is closely relate to the protein moiety of diphtherial cytochrome *b* (1). These observation have, in turn, suggested that diphtheria toxin may exert its injurious a lethal effects by interfering in some manner with the normal functioning the cytochrome system in the tissues of the susceptible host, perhaps b blocking synthesis of cytochrome *b* and related cytochrome components (2 Attempts to verify this hypothesis in guinea pigs and pigeons having lead inconclusive results, it seemed worth while, for reasons which will becor clear in the following paragraph, to study the action of diphtheria toxin c the cecropia silkworm (*Platysamia cecropia* L.).

The transitions of the *cecropia* silkworm from larva to pupa to adult a accompanied by profound alterations in the insect's cytochrome system (Thus almost all of the succinoxidase activity found in the caterpillar di appears at the time of pupation and pupal respiration during diapause app rently continues almost entirely through flavoprotein as terminal oxidase (4 Initiation and progress of adult development are accompanied by rapid a progressive synthesis of all of the components of the cytochrome syste Through the use of *cecropia* as an experimental animal, it thus becom possible to test the action of diphtheria toxin on an organism whose cyt chrome system is undergoing extensive and predictable changes.

It has been found that injection of small amounts of highly purified di theria toxin (0.1 to 1 µg, equivalent to 1 to 10 guinea pig m.l.d.) is suffici to cause delayed death (5 to 10 days) of 5th instar larvae and developi adults. Diapausing pupae, on the other hand, survive 100 µg for seve weeks. Chilled pupae, about to commence adult development, likewise pr ed resistant to large doses of toxin, but injection of only 0.1 µg at this sta sufficed to delay initiation of development for two months or longer. Th the action of diphtheria toxin is a specific one, is indicated by the fact th animals may be specifically protected at all stages by the calculated amo of diphtheria antitoxin.

Moreover even enormous doses, up to 260.000 mouse m.l.d., of an unrel ed bacterial toxin, namely tetanus toxin, are without effect on either diapa ing or developing pupae.

It should be noted that these results are the second instance in which

*) This study was supported by grants from the Commonwealth Fund, the Ameri Cancer Society and the Public Health Service.

invertebrate has been found susceptible to a bacterial toxin. CHORINE (5) showed some years ago that small doses of diphtheria toxin caused death of *galleria* larvae. He also showed that *galleria* larvae were resistant to tetanus toxin.

By far the most dramatic effect of diphtheria toxin in *cecropia* is that which it exerts on the developing adult. By means of thin plastic windows placed in the face or abdomen, WILLIAMS (6) has shown that morphogenesis may be followed from day to day, from the time of its initiation until emergence of the adult moth 21 days later at 25 C. Within a few hours or less, following injection of small amounts of toxin, development is blocked and a state of artificial diapause is imposed upon the animals. However, no obvious damage occurs to the tissues for at least 3 days or more thereafter, and death is delayed 5 to 14 days depending on the dose.

While diapausing pupae survive large doses of toxin for several weeks, the toxin is not without its effect at this stage. Depending on the dose injected, a sudden and complete degeneration of the intersegmental muscles of the abdomen occurs after 6-14 days. Nevertheless, the pupal heart continues to beat normally for 1 to 2 weeks or even longer thereafter. Death due to dessication or entrance of an air buble occurs eventually, doubtless because of degeneration of the minute muscles whose contraction closes the spiracular sphincters. Potassium cyanide, a well-known inhibitor of the cytochrome system, likewise acts selectively on the abdominal muscles without effecting the heart; indeed the isolated heart continues to beat for hours in insect Ringers solution 0.001 molar in KCN. In the case of cyanide, however, the paralysis of abdominal muscles is prompt rather than delayed and temporary rather than persistant; the animals recover after a few days, presumably because KCN is removed through the tracheal system.

In view of the selective action of diphtheria toxin on abdominal as opposed to heart muscle, it was not surprising to find that the two types of muscle show striking differences in their cytochrome spectrum. Thus heart muscle shows only a single faint band at 556 mμ when examined under the Zeiss microspectroscope in the presence of dithionate. The properties of this band are identical with those described for cytochrome x (e?) of the midgut of the caterpillar (4).

By contrast, abdominal muscles examined under similar conditions show intense bands at 550, 562 and 603 mμ corresponding to cytochromes *c*, *b* and $a + a_3$. These spectroscopic differences were fully confirmed by the high succinoxidase activity of the intersegmental muscles as opposed to the minimal activity of heart muscle.

It is of interest that of the many simple chemicals which have been tested only those which inhibit the various components of the succinoxidase or cytochrome system act on diapausing and developing *cecropia* pupae in a manner analogous to diphtheria toxin. These compounds include cyanide, carbon monoxide, pilocarpine and certain other imidazole compounds and deuterohemin.

We feel that the results presented lend support to the theory that diphtheria toxin blocks the synthesis of one or more components of the cytochrome system. In the case of the developing pupa where progress apparently depends on continued cytochrome synthesis, the effect of the toxin becomes manifest at once. On the other hand, in tissues such as the intersegmental muscles of the pupa, the action of the toxin is slow because cytochrome synthesis is here required only to maintain the integrity of a system that is already present.

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DISCUSSION

Mr. **Jucci**: What method has been used for the determination of these cytochromes? Has there been done some research on the metabolism of iron?

Mr. **Pappenheimer**: Cytochrome *c* was measured both spectrophotometrically and manometrically. Cytochrome oxidase (a_3) was measured manometrically using ascorbate as a substrate. Cytochrome *b* (succindehydrogenase?) was measured by determining the rate of anaerobic reduction of methylene blue in the presence of succinate.

Mr. **Agrell**: Does the specific action of diphtheria toxin only concern the synthesis of cytochrome *b* or does it also affect other synthesis processes?

Mr. **Pappenheimer**: We do not know. We believe that cytochrome *b* is involved since the toxin appears to be related to this particular component. However it may well be that synthesis of other cytochromes is also involved. It is hoped that some unicellular plant or animal can be found which is altered but not killed by the toxin. In this event it may be possible to obtain direct spectroscopic evidence for the components involved.

WEIGHT ECONOMY OF FLYING INSECTS

by
Torkel WEIS-FOGH
Gentofte, Denmark

The following discussion is based on studies on the metabolism of flying Desert Locusts (*Schistocerca gregaria* Forskål). KROGH & WEIS-FOGH (1951) found that the respiratory quotient decreased from 0.82 to about 0.75 during the first half hour of "flight" in a small respiration chamber. It was therefore suggested that fat is the predominating fuel for wing movements in migrating locusts. This was confirmed (WEIS-FOGH 1952) by direct analyses of the content of fat and glycogen in controls and in animals which had flown for a number of hours in a specially constructed roundabout (KROGH & WEIS-FOGH 1952). It turned out that in average 85-90% of the energy used during five hours of uninterrupted flight was derived from stored lipids. During flight the metabolic rate was 15-50 times higher than that found during rest. The absolute figures were also considerable (cf. Table 2). Thus the rate with which the wing muscles of locusts converted energy was of the same order of magnitude as demonstrated in flying *Drosophila* (CHADWICK & GILMOUR 1940), i.e. 400-800 kcal per kg muscle per hour. The maximum metabolic rate of human striated muscles hardly exceeds 50 kcal/kg/h (ASMUSSEN, CHRISTENSEN & NIELSEN 1939). Since fat is generally considered an inferior source of energy for intense muscular work the above result was surprising. Moreover, investigations on flying Diptera (CHADWICK & GILMOUR 1940; WILLIAMS, BARNESS & SAWYER 1943; CHADWICK 1947; WIGGLESWORTH 1949) and Hymenoptera (JONGBLOED & WIERSMA 1935; BEUTLER 1937) have shown that these insects exclusively utilize carbohydrates for flight, although they are able to combust fat when resting or running about (WIGGLESWORTH 1949). However, in this connection the discussion will be confined to the weight economy of flying insects and its relation to the combustion of different sorts of fuel.

Storing of fuels. In vertebrates fat can be stored without any additional water and I found the same to be the case in Desert Locusts. Glycogen is the other reserve substance of interest in this connection, which is stored within cells, but contrary to fat it always seems to be present in the dissolved state. In vertebrates this is so whether it occurs as submicroscopical particles (LAZAROW 1942) or within watery vacuoles (TERNI 1924). In the case where glycogen has been described as granules, flakes or solid masses the descriptions refer to material which has been fixed in strong alcohol or in other dehydrating agents. Since storing of water-free glycogen would be specially advantageous for flying insects I tried to find glycogen granules in living insect cells. However, the cells investigated so far, which were known to store large amounts of glycogen, failed to show any solid inclu-

sions of 'animal starch'. For instance, WIGGLESWORTH (1949) demonstrated large amounts of glycogen in the cells situated in the halteres of *Drosophila,* whereas they contained very little fat. In *Calliphora erythrocephala* I was unable to see any glycogen granules in these cells when alive. On the other hand, fixation in alcohol or CARNOY's fluid caused large amounts of glycogen to be precipitated as solid flakes. In the living cells the parts of the cytoplasm which contained the glycogen were completely transparant and turned out to be of a semi-fluid or jelly-like consistence. In the cells of the fat body of bee larvae glycogen appeared similarly and since it has not yet been described to occur as solid particles in living metazoan cells it was reasonable in general to conclude that it is stored dissolved in plasma. The literature on the hydration of stored glycogen has been critically reviewed by MCBRIDE, GUEST & SCOTT (1941) as far as mammals are concerned. They concluded that 1g of glycogen is tied up with 2.7g of water. WATTERSON (1949) and DOYLE & WATTERSON (1949) analyzed the glycogen body of the spinal cord of chick embryos. By combining their data I found the same degree of hydration in these highly loaded cells, the dry matter of which contained sixty to eighty per cent of glycogen. In the following calculations 1g glycogen is therefore considered tied up with 2.7g of water.

Besides intracellular reserve substances some insects can store considerable amounts of strong sugar solutions in the stomach. In bees (BEUTLER 1937) and flies (WIGGLESWORTH 1949), and probably in all nectar-feeding insects as well, these stores can be drawn upon during flight and they should therefore also be considered. As a matter of convenience honey was estimated to contain 20 % of water and nectar 60 % of water.

Different fuels and weight economy.

Table 1

Weight of isocaloric amounts of fuel stored by flying insects

nature of fuel	water content (%)	weight per unit energy (g/kcal)
depot fat	0	0.11
honey	20	0.33
nectar	60	0.67
glycogen	73	0.88

Table 1 shows the weight of isocaloric amounts of different stored fuels. It turns out that as far as saving of weight is concerned, fat is about eight times more profitable than glycogen , honey and nectar being intermediate between the two. But this would only mean little if the metabolic rate during flight was low. However, Table 2 shows that the hourly consumption of stored fuel (k) is very considerable in all insects utilizing carbohydrates.

Table 2

Approximate metabolic rates, the predominating fuels, and the relative hourly consumptions of insects and aircrafts flying under cruising conditions. The data were taken from (1) the papers marked with an asterisk in the 'references' (insects) and from (2) manufacturer's pamphlets (aircrafts)

species or type	approximate metabolic rate (kcal/kg/h)	predominating fuel	k = relative hourly consumption (% of body weight)
insects:			
Desert Locust (*Schistocerca gregaria*)	75	fat	0.8
Fruit Fly (*Drosophila* spp.)	110	nectar + glycogen	7 to 10
Honey Bee (*Apis mellifica*)	300 to 450	nectar + honey	10 to 30
Blow Fly (*Lucilia sericata*)	400	nectar + glycogen	27 to 35
aircrafts:			
conventional modern monoplanes	300 to 500	petrol	2 to 4
jet transporter	1400	"	12
jet fighters	500 to 4000	"	4 to 36
helicopter	500	"	4 to 5

The Desert Locust, on the other hand, combines a relatively low metabolic rate with the ability to utilize fat and k has the very low value of 0.8% per hour. If this insect had to combust glycogen k would increase to 6-7% per hour. The table shows that the high fuel consumption of flying insects, as well as of aircrafts, often must restrict the endurance considerably. This is further illustrated in Fig. 1 which shows the relationship between loading with fuel (in per cent of fuel-free weight) and the possible duration of flight, i.e. the endurance. In insects the loading capacity seldom exceeds 40% and in aircrafts seldom 30%. However, the total loading of aircrafts including crew and payload often amounts to 70% of the empty weight. Nevertheless, the endurance of locusts compares well with the maximum theoretical endur-

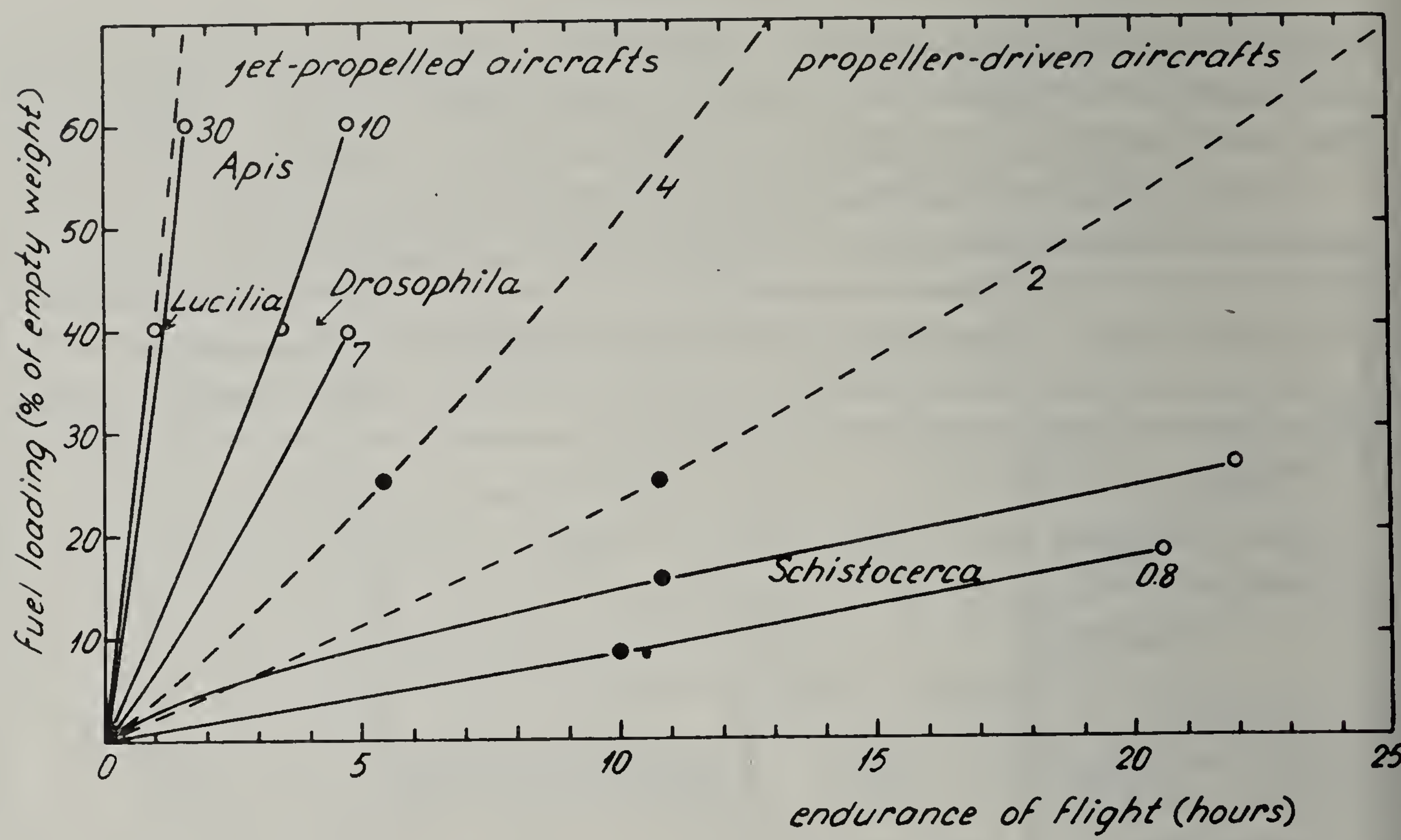

Fig. 1. Relationship between fuel loading in per cent of the empty weight (ordinate) and the endurance of flight (abscissa) in aircrafts and insects. The hourly consumption of fuel (k in Table 2) is seen against the curves. The upper curve for *Schistocerca* refers to a mixture of fat with some glycogen, as found in experiments.
o estimated maximum loading
● average loading

ance of the most economic aircrafts yet constructed, and it far exceeds the endurance of other flying insects investigated so far. If locusts had to combust carbohydrate the endurance would be but 2-3 hours, i.e. long-range migrations can only be performed when fat is made use of. FULTON & ROMNEY (1940) also suggested that fat was used by migrating Jassidae (*Eutettix tenellus*).

Fat utilization in other flying animals.

The question arose whether fat could be used by other animals when flying, but since information on the metabolic requirements of birds and bats is scarce or lacking the problem could only be tackled indirectly. In Table 3 the cost of aerial transport under cruising conditions has been calculated for aircrafts and insects. Whereas the aerodynamic and power-delivering systems differ widely and the weights vary 10^{11} times, the cost of aerial transport within the different types does not vary more than 7 times when we disregard *Apis* and *Lucilia.* Thus the systemic and dimensional advantages of the different groups seem to cancel each other. This means that aerial transport will hardly cost less than 4-5 kcal/kg/km when such small birds are considered which continuously have to flap their wings in order to remain airborne. This means that they would have a metabolic rate of 200-250 kcal/kg/h when flying at 50 km/h. If fat was combusted k would then amount to 2.2-2.8% per hour, whereas exclusive utilization of glycogen would in-

Table 3

Cost of aerial transport under cruising conditions. A comparison between aircrafts and insects

type or species	all-up weight (kg)	air speed (km/h)	cost of aerial transport (kcal/kg/km)
aircrafts:			
large conventional monoplanes	$5 \cdot 10^3$ to 10^5	350 to 550	1
jet transporter	$3 \cdot 10^4$	730	2
small conventional monoplanes	$2 \cdot 10^3$ to $5 \cdot 10^2$	150 to 250	1.5 to 3
jet fighters	$5 \cdot 10^3$	300 to 900	2 to 5
helicopter	$9 \cdot 10^2$	130	4
insects:			
Desert Locust (*Schistocerca gregaria*)	$2 \cdot 10^{-3}$	15	5
Fruit Fly (*Drosophila* spp.)	$2 \cdot 10^{-6}$	15	7
Blow Fly (*Lucilia sericata*)	$3 \cdot 10^{-5}$	15 to 30	15 to 30
Honey Bee (*Apis mellifica*)	10^{-4}		

crease k to about 20% per hour. From Fig. 1 it becomes clear that the known long-range migrations of, for instance, some Passeriformes would be severely hampered if glycogen alone was utilized, and the crossing of seas and larger lakes would hardly be possible if birds were unable to make use of fat for wing movements. Concerning migrating insects other than locusts (i.e. some Odonata, Hemiptera, Coleoptera, and Lepidoptera) similar considerations lead to the conclusion: fat must deliver the main part of the energy for the moving wings in migrating animals. The exclusive combustion of carbohydrates in flying Diptera and Hymenoptera should therefore be regarded as an exception rather than as a rule.

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DISCUSSION

Mr. **Fraenkel**: Are any cases known of fat being utilised by muscles directly, without conversion to carbohydrates?

Mr. **Weis-Fogh**: Yes, CRUICKSHANK & KOSTERLITZ (1941) could demonstrate that both glycogen, glucose, fatty acids and neutral fat disappeared from a working heart-lung preparation. Furthermore BLIXENKRONE-MØLLER (1938) perfused the hind limbs of eviscerated cats with blood containing large amounts of ketone bodies and when the muscles were stimulated electrically he found that the main part of the excessive metabolism was derived from the oxydation of ketone bodies. In general the increasing amount of knowledge seems to indicate that fat can be utilized directly by working muscles.

Mr. **Agrell**: Is there any evidence for a difference in utilizing the bodies fuel during rest and flight for those insects using carbohydrate during flight, possibly indicating a formation of carbohydrate from fat during rest?

Mr. **Weis-Fogh**: The late Professor August KROGH in some preliminary and unpublished experiments on flying Sphingidae obtained results which indicated a conversion of fat into carbohydrate during rest followed by combustion of carbohydrate during the succeeding period of flight. But

* see Table 2

(A detailed account will be published elsewhere.)

did not consider these experiments conclusive and at present no experiments have been published which show with certainty a conversion of fat into carbohydrate.

Mr. **Wigglesworth**: The intensity of muscular metabolism in the flight muscles of locusts and *Drosophila* is not very different. It could be very interesting if Dr WEIS-FOGH could discover why the former can utilize fat while the latter can not. While running about, Drosophila can utilize both fat and glycogen.

Mr. **Weis-Fogh**: Unfortunately nothing is known at present and the study of the metabolic processes is hampered by the fact that the wing muscles of Diptera and Hymenoptera have not yet been made to work in vitro.

THE EFFECT OF PARATHION AND DDT ON CHOLINESTERASE ACTIVITY IN THE ROACH (PERIPLANETA AMERICANA L.)

by

D. STEGWEE

Amsterdam, Netherlands

It is known that several insecticides have a strong inhibitory effect on cholinesterase activity, in vitro as well as in vivo. Their toxic action may be at least partially due to this effect since we know that inhibition of ChE activity interferes with nerve conduction by facilitating and finally blocking it.

As to the physiological action of parathion in vivo only little is known, but the data available render it probable that this action is at least partially based on inhibition of ChE activity. In vitro ChE from bee brains seems alsc to be inhibited by parathion, while an inhibiting effect of parathion in vitrc on the specific ChE from goat blood is also reported.

As for the action of DDT the data available are often contradictory. DDT in vitro seems not to affect ChE activity. After injection of DDT ChE activit in the ventral nerve cord of *Periplaneta* appeared to be unaltered, althougl in the last stages of poisoning a considerable increase in ACh was found. On the other hand DDT is supposed to act as an anti ChE, causing a lower ing of synaptic resistance.

It has been attempted to correlate ChE inhibition and symptoms of poison ing. There seemed to be evidence for a direct relationship between inhibitio and percentage mortality. It is, however, difficult to draw any conclusior since it is known that nerve conduction is not affected at all unless Chl inhibition amounts to about 90%.

The present investigations have been carried out in order to ascertai the effect of DDT and parathion on ChE activity and to try to correlate th rate of inhibition of ChE with poisoning symptoms.

As test animals adult specimens of *Periplaneta americana* L. were usec ChE preparations were obtained from the CNS, i.e. brain and ventral nerv cord, and from meso- and metathoracic leg muscles. ChE determinations we carried out using the manometric WARBURG technique at a temperature 27° C. The insecticides used were:

DDT: pure or as Shell Arkotine dust, containing 5% of technical DDT;

Parathion: purified up to 99.5% (melting point 3° C.).

These insecticides were applied in the following ways:

DDT by putting the animals in a tube of which the inner walls had bee covered with a thin layer of DDT dust or by injecting intra-abdominall 50 micrograms of DDT in rapeseed oil per gram bodyweight;

parathion by allowing the animals to walk on filter paper containing t

residue of an acetone solution of parathion from which the acetone had been evaporated; or by injecting intra-abdominally 2 micrograms of parathion in an aqueous acetone solution per gram bodyweight.

To study the effect of parathion on ChE activity in vitro the enzyme was left in contact with aqueous acetone solution of parathion for one hour before adding the substrate. To eliminate the effect of acetone, blanks were run with acetone only. It was clearly demonstrated that parathion in concentrations varying from 10^{-5} to 10^{-8} M did not affect ChE from the CNS of the roach. This held good for a wide substrate concentration range.

The specific ChE from cow erythrocytes too was not inhibited at all by parathion in vitro.

Now we come to the effect of parathion and DDT on ChE in vivo. The reason for comparing the effects of parathion and DDT was the striking resemblance of the outward symptoms of poisoning. These symptoms are also similar to those brought about by eserine, which substance is known to be a specific anti ChE, so that it would be interesting to know whether the ChE is affected or not after DDT or parathion.

Applying DDT as a contact poison, in the last stage of poisoning, when the animals were almost completely paralyzed, it was found that ChE activity in the CNS had almost entirely disappeared.

Parathion used as a contact poison had the same effect as DDT. When injected it also caused a complete disappearance of ChE activity in the CNS.

When, however, DDT was administered by injection no decrease of ChE could be found, although clear symptoms of poisoning were visible. These rather surprising results will be discussed later on.

As it has been suggested that narcotics have a therapeutic effect on DDT poisoned rats, the effect of CO_2 narcosis on DDT and parathion poisoned roaches was examined. For this purpose the animals were kept under narcosis all over the time of poisoning.

The rather striking results of these experiments showed that DDT, used as a contact poison, caused inhibition of ChE, unless the animals were kept under CO_2 narcosis. Then no inhibition occurred, although after recovery from narcosis the animals showed clear symptoms of poisoning. This effect appeared only after poisoning with DDT dust and did not occur with injected DDT or parathion.

In the last series of experiments, carried out in order to determine a possible correlation between the rate of ChE inhibition and the symptoms of poisoning, it was observed that in parathion poisoned animals that dit not yet show any symptoms of poisoning, the leg muscles had lost some 50% of their ChE activity, ChE activity in the CNS still having its normal value. In the hyperactive stage of parathion poisoning ChE inhibition in the leg muscles appeared to be much stronger than in the CNS.

I should like to discuss these facts later on and first say a few words about the former experiments.

These experiments have demonstrated that in vitro parathion does not in-

hibit ChE from the CNS of *Periplaneta* or from cow erythrocytes. This is in flat contradiction to facts known from litterature. It is not very likely that this contradiction is due to the use of different test animals or different methods. Probably the degree of purity of the parathion used has to be taken seriously into account. Our parathion had a very high degree of purity. Recently it has been established that the in vitro inhibition by parathion is due to the presence of the S-ethyl isomer as an impurity.

As for the effect of parathion in vivo, the experiments with injected parathion and with parathion as a contact poison suggest an in vivo conversion into some active compound.

The experiments with injected DDT showed results similar to those already known. When, however, DDT was used as a contact poison, poisoning symptoms developed much sooner and ChE appeared to be inhibited to a large extent. The question of whether, in the case of contact, DDT is taken up by the nerve endings and transported through the nerves, as suggested by ECKART, the nerves being otherwise impermeable to DDT, cannot be answered at present.

As for the effect of CO_2 narcosis on the action of DDT as a contact poison, no satisfactory explanation has been found. It does not seem very probable that the DDT uptake through the cuticula is inhibited by CO_2, since after the narcosis clear symptoms of poisoning were observed. Perhaps the above-mentioned transport through the nerves is blocked by narcosis, but to verify this, we need to know much more about the action of CO_2 on nerves than we do now.

It seems rather difficult to correlate the symptoms of poisoning with the rate of ChE inhibition. In the introduction I have already pointed out that conduction in the CNS is not affected by inhibition of ChE unless this inhibition amounts to at least 90%. Thus hyperactivity cannot be explained by assuming a partial inhibition of ChE in the CNS. This fact in connection with some of the symptoms, such as the strong hyperreactivity to external stimuli, gave rise to the supposition that the cause of hyperactivity might be found in the peripheral nerves, myoneural junctions or sense organs. The experiments have demonstrated that during hyperactivity after poisoning with parathion, when in the CNS 26-48% of the normal activity is still present, ChE in the leg muscles, including the peripheral nerves, is inhibited for about 89%. This inhibition may be sufficient to produce one or more of the following effects that may be regarded as responsible for hyperactivity: (a) improved conduction in the sensory fibres, (b) improved conduction in the motor fibres, (c) improved myoneural transmission and (d) increased sensitivity of sense organs. Which of these effects are produced is still uncertain. However, if these effects are due to inhibition of ChE (and the anti ChE effect of DDT has been demonstrated in this report), parathion possibly acts in the same way – probably after conversion into some active compound.

Thus we may conclude that the toxic action of parathion and DDT is at least partially based on the anti ChE activity of these compounds.

THE PHYSIOLOGY OF DIAPAUSE IN THE FRUIT TREE RED SPIDER MITE

by

A.D.LEES

Cambridge, Great Britain

Many arthropods from temperate climates possess an inherited disposition to enter diapause. In certain species growth is invariably arrested in each generation; in others, however, the condition remains latent until evoked by the appropriate external agencies. Recent studies have shown that *Metatetranychus ulmi* Koch belongs to the latter class.

M. ulmi lays eggs of two distinct types. The 'summer' or non-diapause eggs are found only on the leaves of the principal host plant (apple) and hatch within seven days at 25° C. The 'winter' or diapause eggs are deposited mainly on the bark and, if collected before the onset of cold weather, always fail to hatch at 25° C., even after 400 or more days at this temperature. The 'summer' and 'winter' females, although morphologically identical, can be distinguished as such by their eggs, since each individual lays only one type if exposed to constant conditions.

Whilst the pattern of the life cycle in nature (i.e. the number and composition of the generations) is relatively stable, this may merely be an indication of the constancy of the significant extrinsic factors. The extent to which the sequence of generations can be modified experimentally may be illustrated by the following examples: (i) mites reared under conditions of long photoperiod and high temperature have yielded an unbroken succession of over 50 summer generations. (ii) Winter females develop in the first post-diapause generation in response to a short photoperiod and low or medium temperatures; in this sequence therefore, all the normal intervening summer generations are missing. The agencies concerned in evoking diapause may now be examined more closely.

The induction of diapause

(a) The *photoperiod* (hours of continuous light per 24 hr.) is particularly important. When reared at a medium temperature (15° C.), exposure to photoperiods ranging from 6 to 12 hours results in the appearance of winter females only (Fig. 1). As the photoperiod is extended from 14 to 16 hours the incidence of diapause falls abruptly to zero. Summer females again appear with photoperiods shorter than 4 hr. and in uninterrupted darkness. Similar curves for photoperiodic induction have now been described in several insects (DANILYEVSKY, 1948; DICKSON, 1949; WAY & HOPKINS, 1951). In the red spider mite the intensity of illumination by white light is immaterial provided it exceeds a threshold of 10-20 lux. Light influences the mites directly and does not exert its effect through the medium of the plant.

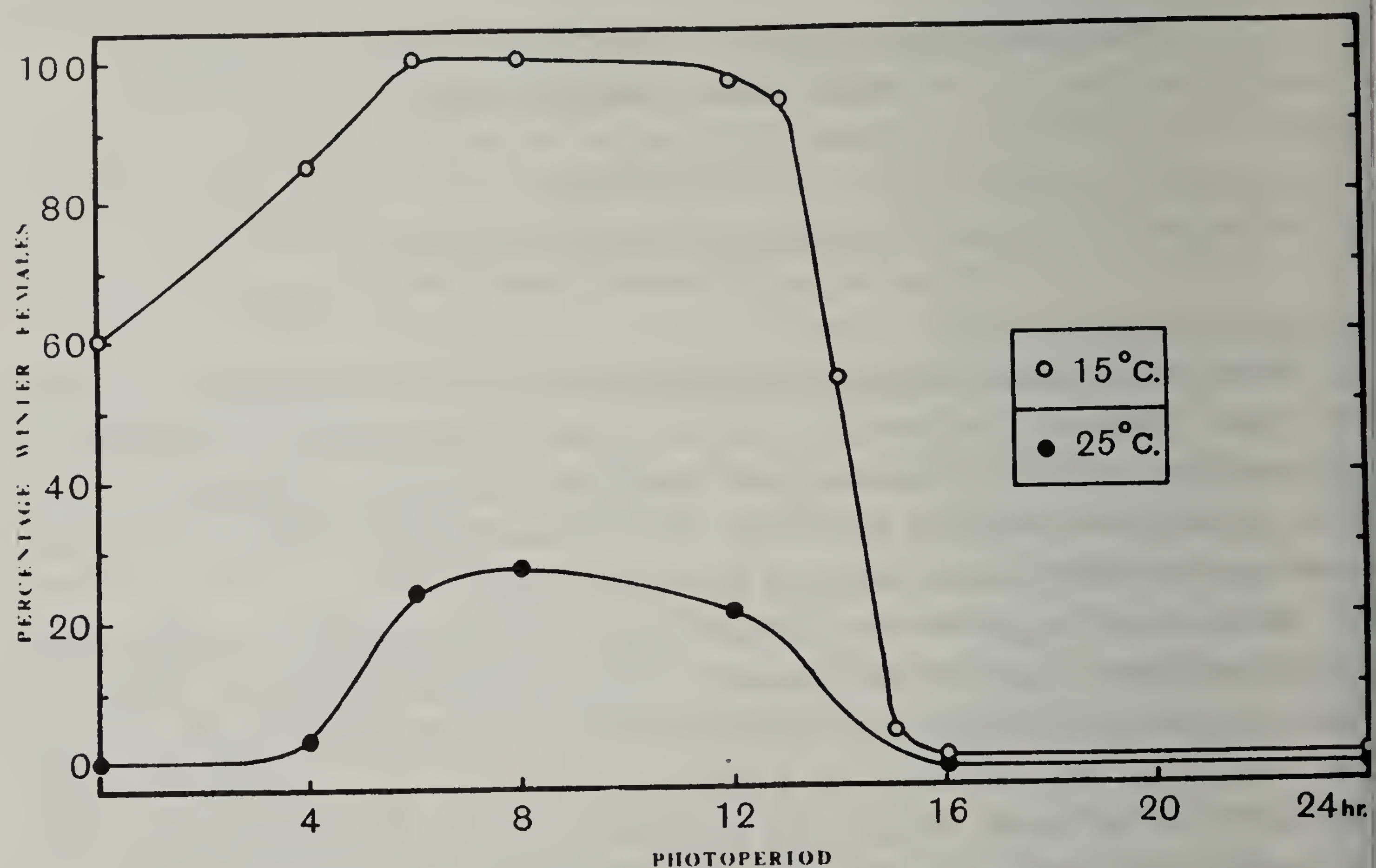

Fig. 1

(b) *Temperature.* High temperatures tend to divert development towards the 'summer' and low temperatures towards the 'winter' condition. At 25° C. a substantial proportion of summer females develop, even with short photoperiods of 8 or 12 hours (Fig. 1). And at 10° C. some winter females appear even with a 16 hour photoperiod.

(c) *Nutrition.* Entomologists studying the life history of *M. ulmi* in commercial orchards have made the interesting observation that winter eggs appear earlier in the season on trees damaged by heavy mite infestations than on normal undamaged trees (KUENEN, 1946; BLAIR, 1951). The type of injury produced is characterized by the severe bronzing of the foliage. In reproducing these conditions in the laboratory with apple seedlings it was found that a variable proportion of the mites reared on bronzed seedlings become winter females even when exposed simultaneously to a high temperature and a long photoperiod. Under such conditions the lack of food may exert a partial overriding influence.

On trees supporting a natural equilibrated mite population severe foliage injury must be rare. It would therefore be surprising if the mite had evolved a mechanism for reacting to leaf damage alone. In fact, winter females are also produced when colonies are reared on senescent (yellowing) leaves. It has been found that if a leaf is still predominantly green, the reproductive fate of mites developing on it is determined solely by temperature and photoperiod. Mites cannot survive on completely yellowed leaves. But if leaves of an intermediate character serve as the source of food, there is again a tendency for development to be diverted towards the diapause state. Since foliage bronzing and senescence are conditions that may have little in common

from the biochemical standpoint, it seems probable that the operative factor is quantitative; the effect may be one of partial starvation.

The nutritive content of both mature and young apple foliage is sufficient for normal growth and these food sources favour the development of neither diapause nor non-diapause forms. Thus all mites feeding on young, rapidly growing spring foliage become winter females if exposed at the same time to a short photoperiod and a medium temperature.

The critical period

Developing mites only become sensitive to temperature and photoperiod (and probably to the nutritional factor also) at the beginning of the last or deutonymphal stadium. The egg, larva and protonymph are all insensitive. It is interesting, however, that even in the adult stage the reproductive function is not irrevocably determined. Thus when egg-laying mites are exposed to antagonistic conditions development may be switched from the production of diapause to non-diapause eggs or *vice versa.* The 'switch-over', which occurs after a definite time lapse, is accompanied by a change in behaviour so that the eggs are almost invariably laid in their appropriate positions on bark or leaf.

The elimination of diapause

The state of diapause can be terminated by chilling the winter eggs prior to placing them at 25° C. for hatching. Temperatures of 1, 5 and 9° C. are about equally effective. But a very lengthy cold treatment is required, the maximum percentage hatch occurring only after the eggs have been chilled for 150-200 days. Although HUECK (1951) has shown that light serves as a stimulus at the moment of hatching, it seems probable that cold is the only agency concerned in bringing diapause to a close in the field.

Interpretation of the life cycle

Recent work has shown that in southern England *M. ulmi* passes through five generations annually (BLAIR, 1950; BLAIR & GROVES, 1951). The winter eggs usually begin to hatch late in April. On trees which continue to carry relatively small mite populations throughout the season (e.g. those in neglected orchards) the first three generations of mites usually consist of summer females only; the 4th includes both summer and winter females; the 5th consists of winter females only. The role of the factors discussed above in determining the course of the life cycle may be somewhat as follows.

The long period of diapause delays hatching until there is foliage available for the young mites. And there is an additional consequence for the 1st generation mites do not reach the sensitive deutonymphal stage until mid-May when the effective photoperiod at latitude 52° is rather more than 15½ hours. This timing therefore ensures that this generation consists entirely of summer females. Since the appearance of the 2nd and 3rd generations coincides with the long days and relatively high temperatures of midsummer, these generations are also composed solely of summer females.

Winter females appear in the 4th generation in spite of the fact that much of the foliage at this time (late August) has only just reached maturity and

is still sufficiently nutritious to support further generations of mites. These winter females have probably developed in response to the shortened photoperiod. Thus the daylength, reckoning from sunrise to sunset, has fallen to 13¾ hours by late August and to 12 hours in the third week of September when the deposition of winter eggs reaches a peak. It is noteworthy that the photoperiod is here serving as a seasonal indicator which operates *before* the arrival of unfavourable weather conditions.

However, the field studies have also shown that some mites may persist on the trees until October or even November when the foliage is rapidly passing from maturity to senescence. We may suppose therefore that the developing 5th generation mites would, in addition, be influenced by the nutritional factor. Under these circumstances the stimuli afforded by the deficiency of food and by the shortened photoperiod would operate in unison.

The foregoing remarks refer to 'natural' conditions where low population densities occur. The situation is otherwise if abnormally large mite populations have caused early leaf injury, for nutrition may then assume a dominant role. In commercial orchards where the rapid build up of the mite population has occurred in early summer, the first winter eggs may be laid by 3rd or even by 2nd generation mites (BLAIR, 1951). Under these conditions exhaustion of the food supplies partially annuls the influence of the long photoperiod.

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DISCUSSION

Mr. **Long**: Since a rather long exposure of 200 days at 2- 3° C is necessary to break diapause, what is the natural effect of sub-zero temperatures for short periods in breaking diapause and what part, if any, does the photoperiod play in breaking diapause in nature?

Mr. **Lees**: I do not know what the effects may be of short exposures to sub-zero temperatures. A constant temperature of -5° C is ineffective in breaking diapause and eventually kills the eggs. So far as I know, light, whether in the form of a natural photoperiod or otherwise, plays no role in eliminating diapause. A fairly complete hatch is obtained even when the eggs are kept in continuous darkness.

Mr. **Pappenheimer**: Have experiments been carried out on the effect of

monochromatic light on production of diapause in non-diapause eggs?

Mr. **Lees**: Using filters with a reasonable narrow transmission range, the mites have been found to be sensitive to wavelengths in the near ultra-violet, blue and green regions of the spectrum, provided the light is of sufficient intensity and is applied as an appropriate photoperiod. The mites are insensitive to red and infra-red.

Mr. **Rivnay**: Regarding the time of hatching of diapause eggs, did you follow and record whether eggs laid earlier by 2nd generation mites also hatch earlier than diapause eggs, or did all eggs hatch together?

Mr. **Lees**: The fate of winter eggs laid abnormally early in the season has not been followed accurately. I suspect, however, that there may be little, if any, influence on the time of hatching.

LA FLUORESCYANINE ET L'ACIDE FOLIQUE, PTERINES DE BOMBYX MORI L.

par

René-Guy BUSNEL

Paris, France

Nous avons isolé des oeufs de *Bombyx mori* (L.) une ptérine à fluorescence bleue, en précisant ses caractères biochimiques (1948) (1). Une étude des pigments des écailles des ailes de *B. mori*, effectuée sur 10 kg de tissus, nous a permis d'isoler une ptérine, également à fluorescence bleue, e ayant des caractères biochimiques très voisins de ceux de la ptérine des oeufs (1950) (2).

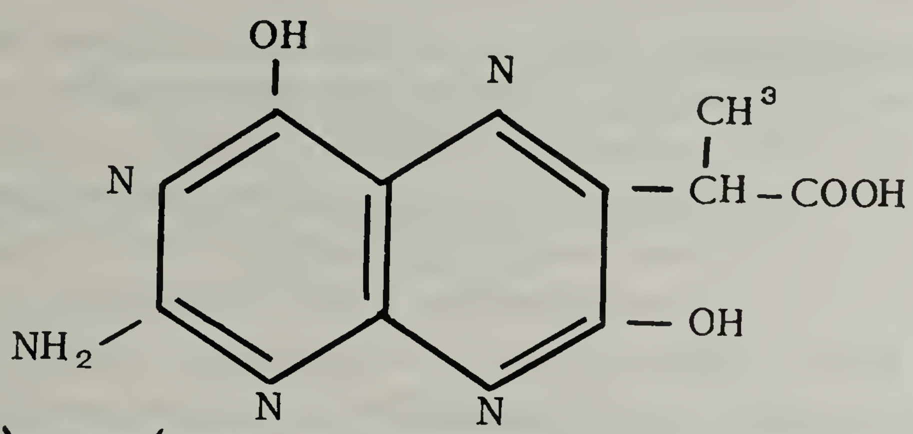
Par la chromatographie de partage, nous avons tout d'abord reconn l'analogie de ces deux ptérines qui ne forment qu'un même pigment (3). Or le retrouve du reste dans d'autres tissus, comme le sang et les tubes de MALPIGHI à des doses plus ou moins concentrées (4).

Ces recherches prirent un nouvel intérêt lorsque nous avons effectué un rapprochement entre la ptérine du *B. mori* (isolée des oeufs ou des ailes avec celle observée dans le mélanocyte de Cyprinus carpio, dès 193 (5) et isolée en 1943 sous le nom de fluorescyanine (6) par POLONOVSKI BUSNEL & PESSON, alors que deux auteurs allemands, HÜTTEL & SPRENG LING, l'étudiaient de leur côté sous le nom d'ichthyoptérine (7).

L'analyse chromatographique sur papier, tant avec le phénol ammoniaca qu'avec le mélange de PARTRIDGE, devait nous permettre (1951) (8) d préciser que la ptérine du *B. mori* et la fluorescyanine des mélanocytes de écailles de Carpe avaient le même rF, caractère qui, s'ajoutant à toutes le autres parentés physico-chimiques des deux ptérines, permettait de le unifier.

A la même époque, HIRATA, NAKANISHI & KIKKAWA (9) reconnurent l présence dans la larve de *B. mori* d'un dérivé de la 6-dehydroxyleucoptérine dont les caractères étaient proches de ceux de l'isoxanthoptérine, notammen par la réaction à l'acide iodhydrique que donne également la fluorescyanine En 1951 (10) ces auteurs reconnurent par chromatographie l'identité de l ptérine qu'ils avaient décrite sous le nom de dérivé 6-dehydroxyleucoptérin avec la fluorescyanine, et ceci pour des extraits provenant de divers tissu du *B. mori*, oeuf, tubes de Malpighi, ailes.

Si la constitution ptéridinique de la fluorescyanine ou ichthyoptérine n faisait plus de doute depuis nos premiers travaux (1938-43) et ceux d HÜTTEL & SPRENGLING (1943) elle vient d'être entièrement confirmée p TSCHESCHE & KORTE (1951) (11). En effet ces auteurs ont identifi l'ichthyoptérine de HÜTTEL, ou fluorescyanine de POLONOVSKI, BUSNE & PESSON, à l'acide 6-9-dihydroxy-2-amino-ptéridine-8-acétique, qu'ils o réalisé par synthèse, avec ses dérivés. Ils en ont donné le schéma suivant



Nous avions déjà montré que dans les divers tissus de *B. mori* et dans ceux des Vertébrés Inferiéurs, la fluorescyanine peut s'associer à des protéines pour former un complexe enzymatique, comme d'ailleurs la riboflavine (12); à cet égard nous rappellerons que la riboflavine coexiste avec la fluorescyanine dans l'oeuf et les tubes de MALPIGHI du Ver à soie, soit sous la forme libre, soit sous sa forme liée (13).

La fluorescyanine chez *B. mori* est copulée avec un groupement polypeptidique (14) et ce caractère est d'autant plus intéressant à signaler qu'il rejoint le cas d'une seconde ptérine, l'acide folique (acide ptéroylglutamique), complexée avec un nombre variable de molécules d'acide glutamique, alors que la copule de la fluorescyanine comprend d'autres amino-acides. Cette propriété éloigne beaucoup ces deux ptérines de celles décrites dans les Pierides, la xanthoptérine et la leucoptérine, que l'on s'accorde à considérer comme inertes, alors que ces ptérines copulées sont comme le ferment jaune, des transporteurs d'hydrogène.

Bien que très voisine de l'acide folique, dans sa structure nucléaire, la fluorescyanine ne saurait en dériver directement et doit procéder d'un anabolisme légèrement différent.

Nous avons également décelé la présence d'acide folique dans les oeufs et les tubes de MALPIGHI du *B. mori*, et son absence dans les écailles des ailes par le test de croissance de Streptococcus faecalis (16). La fluorescyanine est au contraire dépourvue de toute activité vitaminique vicariante de l'acide folique sur le même S. faecalis. Ce résultat s'oppose à la vacariance de la même ptérine chez le Rat et le Pigeon en avitaminose B_1 et s'inscrit dans la même ligne que la discordance déjà constatée entre l'action vitaminique positive B_2 chez le Rat mais entièrement négative chez Polytomella coeca (17).

Cette analogie d'engagement entre les deux ptérines connues, isolées des divers tissus du *B. mori*, avec la riboflavine, complexée d'une manière identique dans les mêmes tissus (oeuf, tubes de MALPIGHI), permet de souligner que la fluorescyanine a un rH très proche de la flavine, lui permettant de jouer dans les phénomènes respiratoires de la cellule un rôle que nous avons pu mettre en évidence dans le mélanocyte (18), mais qui reste cependant à démontrer dans le cas de l'oeuf ou du tube de MALPIGHI de *B. mori*.

Il ressort de nos récentes recherches entreprises sur la mélanogénèse (19), que la fluorescyanine est susceptible d'intervenir au cours de ce pro-

cessus; par analogie, on est amené à penser qu'il en est peut-être de même au cours de l'ommatogénèse, au moins pour le *B. mori*, dont le pigment des oeufs et des ailes est une ommatine caractérisée (20).

Ainsi, les deux pigments ptéridiniques définis actuellement chez le *B. mori* à ses divers stades et dans ses divers tissus ont un caractère ubiquitaire qui va de pair avec leur importance physiologique. De même que l'acide folique et la xanthoptérine, isolés aussi bien du règne végétal que d'un très grand nombre d'organes de multiples espèces animales, la ptérine principale décelée dans l'oeuf du Ver à soie, le sang, les tubes de MALPIGHI, les ailes, est la même que celle déjà caractérisée dans le mélanocyte des Crustacés et des Vertébrés Poecilothermes.

Les formes sous lesquelles ces nouveaux pigments se rencontrent dans les organismes vivants, sont multiples, et probablement aussi les processus enzymatiques auxquels ils participent. Mais de nombreux travaux restent encore à entreprendre avant que nous ayons une vue précise et générale du rôle biochimique de ces complexes ptéridiniques.

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ORIENTIERUNGSVERSUCHE AN STOMOXYS CALCITRANS UND CULEX PIPIENS MIT EINEM BLUTDUFTSTOFF

von

B. SCHAERFFENBERG und E. KUPKA
Grax, Österreich

Für das Auffinden des Wirtes durch blutsaugende Dipteren werden verschiedene Faktoren verantwortlich gemacht, so die von ihm an die Luft abgegebene Feuchtigkeit, Kohlensäure und Wärme. Ausserdem wurde eine attraktive Wirkung der ausgeatmeten Luft, sowie der freiliegenden Haut festgestellt.

Verschiedene Beobachtungen aber sprechen dafür, dass auch das Blut selbst anlockend wirkt. So wirkt nicht nur freies Blut anziehend, sondern auch die stark durchblutete Haut. Bei Fieber, nach anstrengender Tätigkeit, sowie unmittelbar nach einem Bade ist die Haut durch Erweiterung der capillaren Blutgefässe stark gerötet. In diesem Zustande hat sie eine besonders starke Anziehungskraft für Blutsauger. Offenbar diffundiert ein besonderer Blutduftstoff durch die Haut, der natürlich auch in der Atemluft reichlich vorhanden sein muss. Sein Vorhandensein erklärt auch das sichere Auffinden und Anstechen der Blutgefässe durch die Dipteren.

Auf Grund dieser Überlegungen führten wir verschiedene Arten von Versuchen durch:

1. Köderversuche mit Leimfliegenfängern, die einen Zusatz frischen Blutes erhielten. Ihre Fängigkeit für *Stomoxys calcitrans* L. war gegenüber den Kontrollfängern etwa um das Doppelte erhöht. Für Culiciden lag sie sogar bis 10 mal höher.

2. Anlockungsversuche mit Harnblasen von Meerschweinchen, die mit frischem Blut gefüllt waren und sowohl von *Stomoxys* als auch von *Culex* eifrig besucht und angestochen wurden.

3. Orientierungsversuche mit Blutserum und verschiedenen bekannten Bestandteilen des Blutes. Geprüft wurden: Serum Albumin, Serum Globulin, Glucose, Cholesterin, Lezithin und Haemathin. Alle diese Substanzen erwiesen sich als nicht attraktiv.

4. Versuche mit Blutfraktionen. In Zusammenarbeit mit Dr. O. BALLAUS als Chemiker gelang es eine wirksame Duftkomponente des Blutes zu finden. Der überaus flüchtige Stoff ist farblos, von leicht süsslichem Geruch, der an denjenigen des Blutes erinnert. Für unsere Versuche stand er uns nur in sehr verdünnter, wässeriger Lösung zur Verfügung.

Zur Prüfung der attraktiven Wirkung auf *Stomoxys calcitrans* L. und *Musca domestica* L. wurde den Fliegen in je einem Schälchen 2%-ige Zuckerlösung geboten, wovon eines zusätzlich 0,05% unserer Duftstoffausgangslösung enthielt. Bei einem Käfigbesatz von 100 *Stomoxys* und 25 *Musca* wurde innerhalb einer Stunde und 50 Minuten die beduftete Lösung von 219 Wadenstechern

und 66 Stubenfliegen besucht, wohingegen sich bei der reinen Zuckerlösung 9 *Stomoxys*, aber 62 *Musca* einfanden. In einem weiteren Versuche mit 40 *Stomoxys* und 12 *Musca* von einer Stunde und 10 Minuten Dauer wurde 2%-ige Zuckerlösung gegen beduftetes (0,05%) reines Wasser geprüft. Den Duftstoff besuchten 66 *Stomoxys* und 37 *Musca*, die Zuckerlösung hingegen nur 26 *Stomoxys*, aber 54 *Musca*.

In beiden Fällen hatten sich demnach mehr als doppelt soviele Wadenstecher bei der bedufteten Lösung eingefunden, während die Stubenfliege den Duftstoff nicht merklich bevorzugte.

Während die Fliegenversuche bei Tage durchgeführt wurden, mussten die Teste mit Culiciden in der Nacht bei monochromatischem, roten Lichte erfolgen. Im ersten Versuch wurden 110 *Culex*-Weibchen bei 26° C im entsprechenden Käfig beobachtet. Bei reinem Wasser fanden sich bei einer Versuchsdauer von 2 Stunden und 20 Minuten 11, bei 2%-iger Zuckerlösung 21, bei Wasser mit 0,01% Duftstofflösung 17, bei 0,02% Duftstofflösung 20, bei 0,05% 52 und bei 0,1% 64 Tiere ein. Mit steigender Duftstoffkonzentration nimmt also die Frequenz der Tiere proportional zu. Danach wurden die 0,05%-ige und 0,1%-ige Duftstoffkonzentration gegenüber den Kontrollen zwei- bis dreimal so stark besucht.

In einem zweiten Versuche mit 60 *Culex*-Weibchen von zwei Stunden Dauer bei 24° C wurde 2%-ige Zuckerlösung, sowie 0,02- und 0,05%-ige wässerige Duftstofflösung geboten. Die Ergebnisse waren folgende: Zucker 26, 0,02% 13 und 0,05% Duftstoff 53 Tiere.

Ein dritter Versuch lief mit 200 Stechmückenweibchen durch 2 Stunden bei nur 21° C. Hier waren neben der Zuckerkontrolle Schälchen mit 0,01-, 0,1- und 1%-igem duftstoffhaltigem Wasser aufgestellt.

Die auftretende Verteilung der Tiere war folgende: Zucker 89, 0,01% 16, 0,1% 44 und 1% 94 Stechmücken. Auch dieser Versuch zeigt die Konzentrationsabhängigkeit der Duftwirkung. Zugleich geht aus den drei angeführten Stechmückenversuchen deutlich hervor, dass die anziehende Wirkung des Blutduftstoffes von der herrschenden Temperatur abhängig ist. Besonders klar kommt dies bei dem letzten Versuch bei 21° C zum Ausdruck, wo die Geruchskomponente 20 mal so hoch konzentriert werden musste als bei den vorhergehenden, um auch nur eine merkliche Bevorzugung gegenüber dem Zucker zu erreichen.

Durch diese Versuche konnte also neben dem Nachweis eines wirksamen Blutduftstoffes die bedeutsame Feststellung getroffen werden, dass die Stechstimmung der Culiciden direkt durch Witterungsfaktoren ausgelöst wird. Luftbewegungen und Licht bezw. Strahlung sind hier auszuschliessen, da wir in geschlossenen, finsteren Räumen arbeiteten. Luftdruck und Luftfeuchtigkeit waren dagegen nicht berücksichtigt worden.

In weiteren Versuchen konnten wir bei *Stomoxys* und bei *Culex* zeigen, dass sowohl tierische Membranen als auch einfache Filterpapierlagen von den Tieren mit ihrem Stechapparat durchbohrt werden, um zur bedufteten Lösung zu gelangen. Der Blutduftstoff bewirkt demnach ausser der Anlockung auch die Auslösung des Stechaktes.

Damit scheint der wichtigste Faktor für die Anlockung der blutsaugenden Dipteren gefunden zu sein, der sicher noch durch weitere Faktoren, wie Kohlensäure, Feuchtigkeit und Wärme in unmittelbarer Nähe des Wirtes unterstützt wird.

Weitere Untersuchungen zur chemischen und physiologischen Aufklärung des Problems sind noch im Gange.

SECTION V

ETHOLOGY
(ANALYTICAL BEHAVIOUR STUDIES)

THE RETURN OF ANTS TO THEIR NEST

by
J.D.CARTHY
London, England

There is now ample evidence that ants can find their way visually either by means of landmarks – and here they apparently react to the whole set of stimuli comprising the visual background – or by means of the pattern of polarised light, as the author has shown in *Acanthomyops (Lasius) niger* (1951) and VOWLES has demonstrated so effectively in *Myrmica laevinodis* (1950). But there is less clearly defined evidence for orientation along scent trails. There has been much controversy concerning the existence, and more particularly, the orientation of such trails, controversy which has continued to the present day as CHAUVIN's (1948) recent inability to repeat BETHE's original (1898) results has shown.

The trail left by *Acanthomyops (Lasius) fuliginosus* workers can be plainly seen (CARTHY 1950, 1951). It consists of a series of streaks each of which tapers to a point in the direction in which the ant is moving. The substance is gut contents containing pieces of peritrophic membrane ejected through the anus. The motion of wiping the anus along the ground can be seen, for the worker raises its body by extending its legs and then flexes its abdomen so that the tip is in contact with the ground. These observations were made on individual workers transporting larvae back to an artificial nest from the centre of a glass arena. BRUN (1914) failed to find any indication of a scent trail in this species when they were carrying larvae, but it appeared that they were following a trail when they carried food.

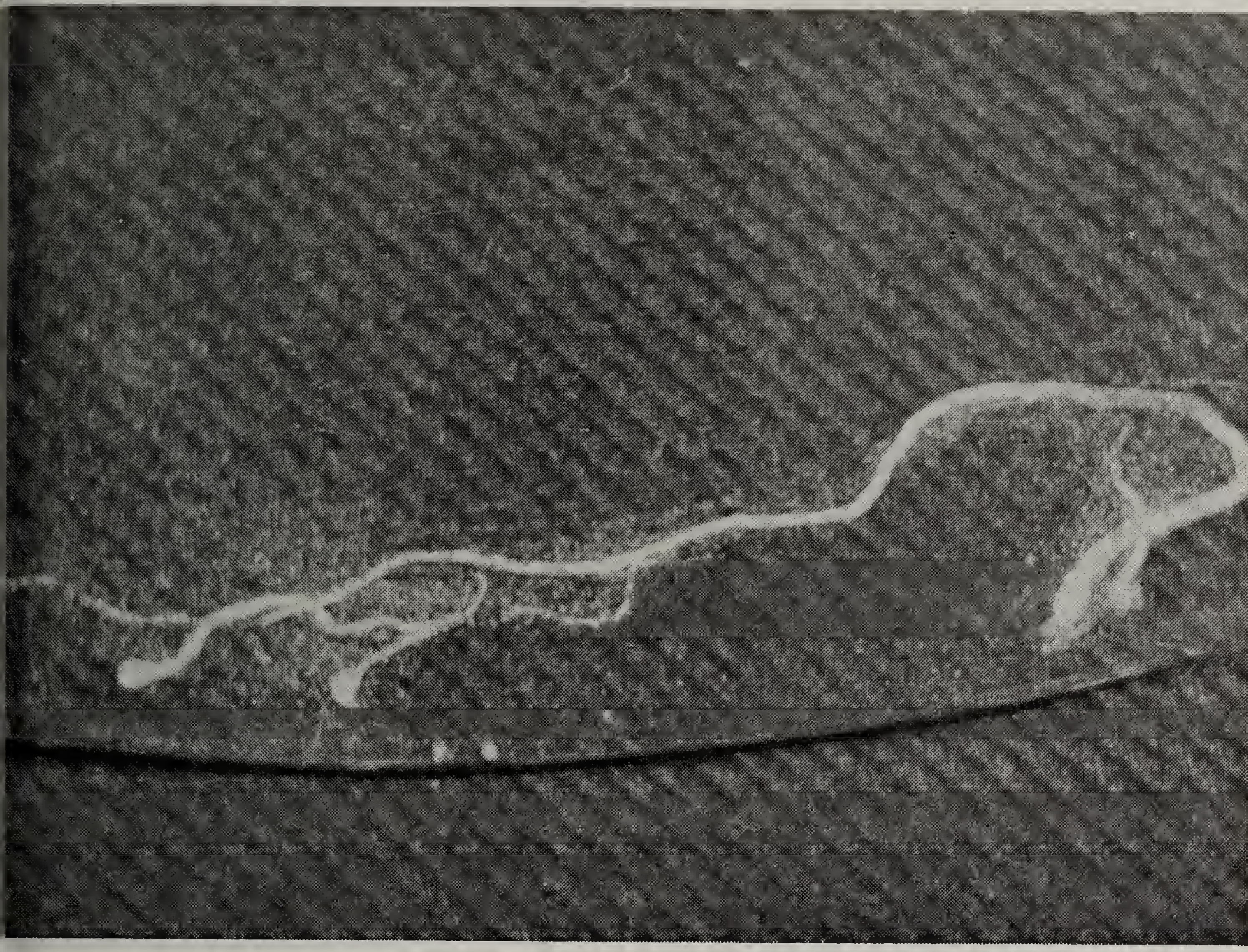
In the experiments a pile of larvae was used as the bait so that the impulse to collect and return to the nest would remain at a maximum without being reduced as would happen after satiation with food. Once a trail was established it was followed in a general manner but not in detail. A worker would run with its antennae bent down to touch the ground, one antenna making contact with the trail. If the trail was interrupted in the classic manner by drawing one's finger across it, the worker lost its direction completely on reaching the spot and circled about. When the plate was dusted with lycopodium powder to show the trail, the finger mark showed as a smear across the track so that apart from erasing the streaks foreign substances had been laid as a barrier across the way. If however the experiment was repeated using a dry cotton wool swab, the disturbance was not so great, in fact, the ant continued in the main direction in which it was heading, and no smear was made. Thus provided that the width of the gap in the trail was not great the worker's ability to maintain a direction once taken up for a small distance enabled it to cross the space, whereas the alien odour caused a violent up-

set in the olfactory background and prevented the animal from maintaining any form of orientation. Similar considerations apply to the trails of *A. niger* in nature, for a slight disturbance of the topsoil causes little disruption of the foragers, while the odour left from one's finger does, making them run hither and thither breaking up the orderly march of the column. This continues until one or two individuals do cross the barrier of scent and then increasing numbers cross until the file is reestablished. Now from laboratory experiments it appears that this ant uses light, and most probably polarised light from the sky, for its orientation. The result of the "finger experiment" in nature corroborates other laboratory experiments which suggest that though orientating visually the ant is also being constantly stimulated by the olfactory background, disturbance of which will cause a general disturbance of the orientating ability. A point of difference between these experiments and those of the earlier workers is that they were carried out on individuals whereas previous observers had concerned themselves apparently with numbers of foragers at the same time. There might be a difference in "Mass" orientation and "Individual" orientation as BRUN (1914) suggested.

This may also be the explanation for the differences between MACGREGOR's (1948) results and those of the author on *Myrmica ruginodis* (unpublished). From his experiments on food-foraging in this species MACGREGOR concluded that the workers used a scent spot to guide them to the nest from the food. This apparently had an innate orientation since blinded ants could react to it. When the author retested this species in an arena, setting a problem of retrieving larvae, no such scent spot was indicated. In fact, the individual workers behaved as though they were finding their way visually, since they were disorientated in red light, or when a screen was erected around the arena but they remained unaffected when the glass floor of the arena was rotated through 180° before their return. However when they were allowed to forage for food, marks were left on the glass (Figure) which appeared to have no orientation and were generally positioned far off the direct track from food to arena exit. Further work will be necessary to find out the significance of these marks. VOWLES (1950) in his work showed the very closely allied species, *M. laevinodis*, to be orientating visually, though in this case they were wandering and were not on a specific journey back to the nest laden with food or a larva.

The trail in *A. fuliginosus* does not retain its full effectiveness indefinitely. It appears to dry sometimes after 5 minutes, sometimes after 1 hour this drying appears to be coupled with a loss of effectiveness and may or may not be its direct cause. However that may be such a reduction of effectiveness will be an advantage since disused trails will lose their attractiveness and not draw off foragers from more productive areas.

The streaks are laid mainly on the return journey from the larvae though sometimes small dashes of secretion are left during the outward journey. It appears that the stimulus to mark a trail is the discovery of larvae and the consequent excitation caused by it. The excitation which accompanies loss



The traces left by *M. ruginodis* foragers on the floor of an experimental arena, when food bait was used, photographed after dusting with lycopodium powder. Total length about 3 cms.

of direction in *A. niger* also induces the deposition of anal secretion, one of the rare occasions upon which marks of this sort are left by workers of this species. This fact that the trail is only laid when a successful end has been reached coupled with the gradual loss of attractiveness of the trails will have a practical application in the foraging economy of the nest, for it will be only those trails which are reinforced by successful workers which will attract the emerging foragers. IBBOTTSON (personal communication) has found that the mobilisation of workers to particular sugar solutions set out for them is in direct proportion with the concentration of food, this, however, in *A. niger*. If such a relationship exists in *A. fuliginosus*, the explanation might reside in different concentrations of excretion on the various trails. It will be interesting to study the threshold concentration in food which is necessary to cause the deposition of a trail. The actual mechanism of laying will also repay further investigation.

SCHNEIRLA & BROWN (1950) have found that the trails of *Eciton* spp, which are marked with a strong smelling anal excretion, retain their effectiveness for long periods, even surviving heavy rains. Also the odour is apparently not specific to any colony nor indeed to any species; raiding columns from one colony may strike, follow and finally incorporate sections of other colonies' disused trail systems. The greater rigidity of the foraging plan in

these blind ants dependent so much on odour for their nest relationships and for trail following arises partially no doubt from the permanence of the trail substance once it has been laid. *Fuliginosus* is not so fixed in its foraging systems since the workers have functional eyes and can thus forage singly away from the main concentration of workers, initiating numerous trails.

In an earlier paper SCHNEIRLA (1948) has made some interesting suggestions as to the origin of the trail following instinct. He suggests that the nest is soaked with the same odour, the young workers on emergence will therefore become imprinted with this particular odour and thus learn the specific releaser for trail following when it emerges from the bivouac. A study of this aspect of trail following behaviour in *A. fuliginosus* has not yet been started, but on first thoughts will probably not produce similar results. The strongest odour (to the human) in the nests of *fuliginosus* is that slightly acid smell, particularly strong after a disturbance, which has best been described as like "cheap lemonade powder". This appears to arise from the mobile wax which covers the insect for a chloroform preparation of the wax yields a residue with the same odour after the solvent has been allowed to evaporate. This nest odour appears to have no connection with the pathmarking scent.

There still remains a number of other questions to be solved in this study of trail laying in ants and the whole foraging behaviour itself also supplies much material for further research.

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DISCUSSION

Mr. **Siddorn**: Did LUBBOCK not mention that in his experiments in whic[h] part of an ant trail was reversed, a later forager coming upon the reversed trail took the wrong direction?

Mr. **Carthy**: Yes, but his technique may have been faulty — the reverse[d] section of the trail may have had rough edges and may have stimulated anot[h]er sense than olfaction.

Mr. **Williams**: I have seen in British Guiana similar ant behaviour to tha[t]

described by Mr. CARTHY. Could the ant tell – on meeting a trail – at which end lay the food supply.

Mr. **Carthy:** Though the odour trail has an orientation inherent in the shape of the spots, the shape does not appear to be appreciated. Thus the ant cannot tell in which direction to turn on meeting a trail, but of course is likely to be right in 50% of cases.

HOST SELECTION BY CEPHALONOMIA WATERSTONI GAHAN. (Hym. Bethylidae)

by

L.H. FINLAYSON
Birmingham, England

Previous work (FINLAYSON, 1950) with populations of *Cephalonomia* and its host *Laemophleous* showed that the wasp will attack the three common species found in stored products but has a preference for *L. ferrugineus*. *L. minutus* is fairly acceptable but *L. turcicus* was not readily attacked. Egg laying behaviour is more specific than attack behaviour; rarely are eggs laid on *L. turcicus*. The behaviour of individual *Cephalonomia* is now being studied and the following is a preliminary report of some of the work.

Female *Cephalonomia* whose ages were known to within 6 hours from emergence were isolated at 30° C. and 80% R.H. They were offered larvae of *Laemophloeus* at the beginning of the experiment and then at intervals of 6 or 12 hours. The tests were carried out at 25° C. and 70% R.H. The larva was placed in a piece of glass tubing about 4 cm. long with an internal diameter of 2 mm. One end of this tube was plugged with paraffin wax. *Cephalonomia* does not recognise her host until she touches it with her antenna. All the flagellar segments except possibly the basal carry the receptors by which recognition is effected. When the female under observation touches the larva with one or both antennae (shorthand TA) a stopwatch was set off and she was allowed 1 or 2 minutes in the tube or until she had touched at least twice. In most cases TA occurred many times and in the few in which it occurred only twice it was clear that the wasp had sufficient contact with the host for stimulation to take place. If the *Cephalonomia* attacked the larva by biting and then stinging it (BS) the watch was stopped and the interval from TA to BS was recorded. The wasp was separated from the larva at once and tested on the next species within a few minutes or returned to 30° C. and 80% R.H. It was never allowed to feed during the experiment. In one experiment *L. turcicus* and *L. ferrugineus* were offered, in another *L. minutus* and *L. ferrugineus* and in the rest *L. turcicus, L. minutus* and *L. ferrugineus* all in the order given.

The results are shown in Fig. 1. Most of the wasps attacked *ferrugineus* during the first 12 hours after emergence. At first it was hoped to time the initial attack to within 6 hours and tests were made at 10.00, 16.00 and 22.00 h. approximately. Unfortunately the large numbers of insects which would be required made this impracticable. However it showed that *ferrugineus* was attacked at the first test when the *Cephalonomia* was not more than 6 hours old by 58.6% of the wasps. Most of the attacks on *minutus* took place in the first 24 hours, a few more in the second period of 12 hours than in the first; 12.5% were attacked during the first 6 hours. All the *Cephalo*

nomia attacked *ferrugineus* by the time they were 24 hours old but some did not attack *minutus* until they were about 5 days old and a few died without attacking at all. The results for *turcicus* show a greater spread than for *minutus* but still with a peak around the first 24 hours. Only 5% attacked in the first 6 hours. More died without attacking *turcicus* than *minutus*.

The average interval in seconds between TA and BS for the first attack was 11.81 (*ferrugineus*), 14.34 (*minutus*) and 21.34 (*turcicus*). Thus the drop in the threshold necessary before a host is attacked does not seem to result in an identical state in relation to the different host species. The threshold may drop until *turcicus* is accepted but the response of the wasp to *turcicus* is slower than to *minutus* and the response to the latter is slower than to *ferrugineus*. This indicates that more than one factor is involved in the "host-stimulus" (fig. 2). At the second response to one species of host the time lag from TA to BS is about halved and the third attack is almost instantaneous with TA on all three species. The final condition in which the response is very rapid is reached after a short time or may be the state on emergence in relation to *ferrugineus* but in relation to *turcicus* it is usually reached only when the insect has almost starved to death. The fact that about 25% of the *Cephalonomia* died of starvation without having attacked *turcicus* shows how profound is the physiological change necessary to make any responsive. It is possible of course that all would have responded to *turcicus* before dying if the tests had been more frequent.

The behaviour of adequately nourished females was investigated. Each female was given a *ferrugineus* larva soon after emergence and then tested with a fresh *ferrugineus* larva each subsequent day. If she attacked the test larva it was returned with her to her container. Each female therefore received an additional larva when she appeared to be hungry. This experiment showed that *Cephalonomia* enters a period of quiescence after feeding on *ferrugineus* during which she is indifferent to all host species. This period lasted, at 25° C. and 70% R.H., for 1 or 2 days in two thirds of the females and for 3 days or more in the rest. Fourteen attacks took place when paralysed larvae (with or without parasitised but no active), 8 when parasitised larvae only and 2 when active larvae were available in the female's own container and there were 15 cases of females dragging paralysed larvae. When a female was dragging she was not disturbed. Hungry *Cephalonomia* will readily attack paralysed larvae and it is interesting to see that the paralysed larvae in the tubes in which females were kept between tests were apparently not so stimulating as fresh active larvae in clean experimental tubes. Also interesting are the records of attack on fresh larvae although active larvae had been available. Both records are for the same insect and, as the record shows that the active larvae must have recovered from paralysis, the case is not straightforward.

From these results it would seem that a female which had fed at all would be most unlikely to attack a non-preferred host except when she had ripe eggs to lay. It was thought that a strong ovipositional drive would result in

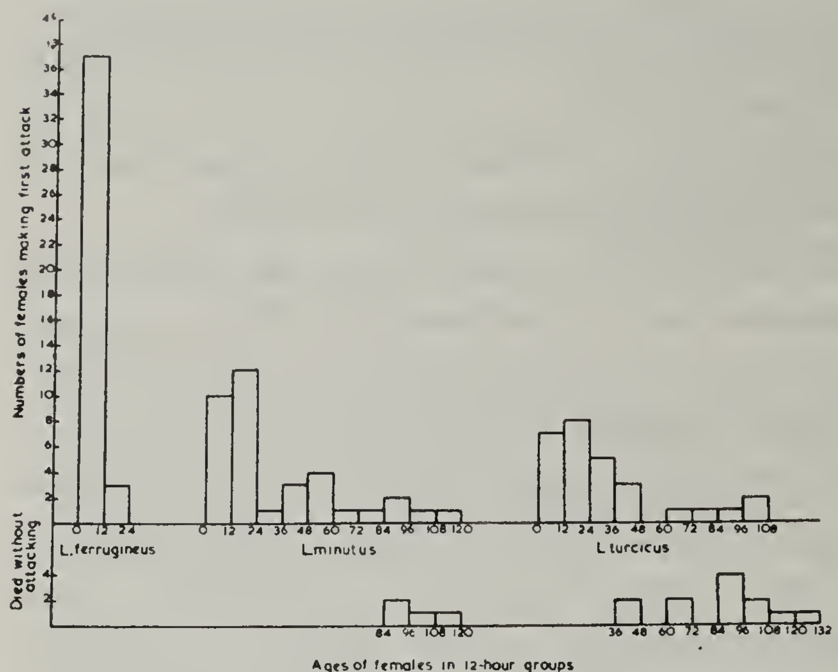

Fig. 1. Ages of *Cephalonomia* females when they first attacked three species of *Laemophloeus* and ages at death of those which died without attacking. In the *minutus* and *turcicus* tests 40 *Cephalonomia* were used; in the *ferrugineus* tests 58 with the results adjusted for comparison.

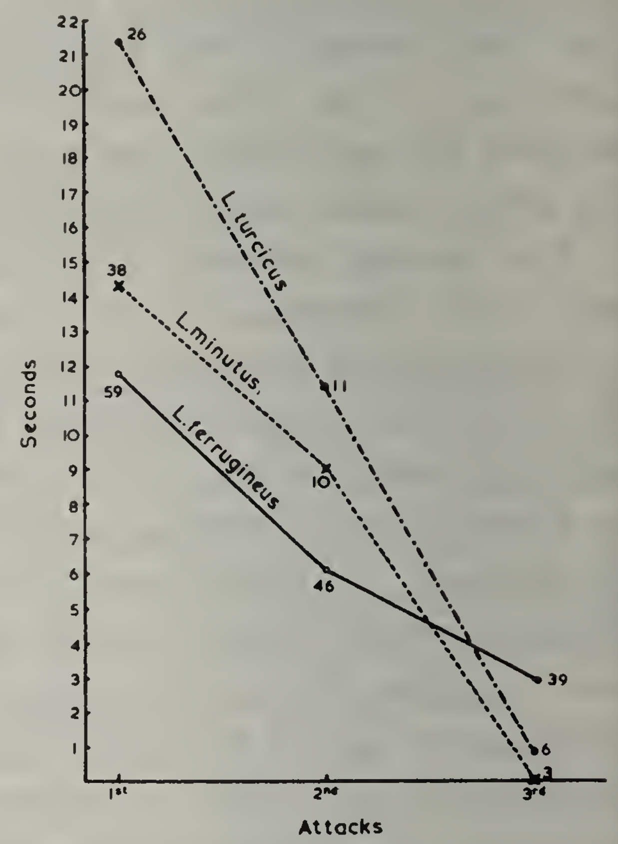

Fig. 2. Time in seconds from TA to BS for the first three attacks on *Laemophloeus* species. At each point is given the number of *Cephalonomia* which attacked.

attack on *turcicus* and so well-fed females which had not laid any eggs and which from their behaviour in dragging *ferrugineus* larvae were probably ready to lay were presented with *turcicus* larvae. None of them attacked the larvae, but only a few have been tested so far. A point which arises is the possibility of resorption of the eggs during starvation as in many Hymenoptera (FLANDERS, 1942; GROSCH, 1950) so that by the time the threshold is low enough for attack on *turcicus* there are no mature eggs left. However, eggs *are* sometimes laid on *turcicus* so if oosorption occurs it does not always prevent oviposition.

In an experiment on the lowering of the threshold by starvation a *Cephalonomia* attacked (BS) the wax plug at the end of the experimental tube in which a *ferrugineus* larva had been enclosed for a day or more. Brushes which have been used frequently for handling *ferrugineus* become stimulating and BS sometimes takes place on them. Model larvae consisting of small pieces of white cotton thread untreated or impregnated with paraffin wax, nylon thread (fishing cast), silk thread, and white cardboard were left for a day or more among 50 or more *ferrugineus* larvae and then offered to starving *Cephalonomia*. The silk and the cardboard seemed to be the most stimulating; the nylon models were no more "interesting" than the controls. The others came somewhere between. In no case was the model bitten or stung. The behaviour of the wasps never passed the "interest" stage during which the antennae are vibrated rapidly and the object of interest is palpated frequently. If the object was very interesting the wasp remained in contact with it for comparatively long periods.

Extraction of the stimulating substances from larvae was attempted using 'ater, chloroform, ether, methyl alcohol and xylene. Models were placed in ıe extract and the solvent evaporatedoff. Positive responses were obtained 'ith water only but not if it was filtered. It is likely that the substances are dsorbed on starch grains, fragments of bran, faeces etc. which are removed y filtration. Powdered activated charcoal in which *ferrugineus* larvae have een crawling becomes stimulating to *Cephalonomia.*

None of the models tried so far have been sufficiently stimulating to cause iting and stinging although the full response has been released by the wax lug and the brushes as already stated. It does not seem likely that there is strong tactile element in the stimulus complex because a full response can e elicited by these objects and also because the response of a female whose hreshold is low follows the merest touch with the antennae and is too rapid o time. The "interest" stage is omitted entirely.

It is hoped that it will be possible to analyse the contact-odour (or taste) timulus more thoroughly. The information possessed about the host relations ıay be useful. For example it may be possible to make *turcicus* a "complete" ost by the addition of a factor or factors possessed by other species. Of nterest in this connection is the following observation. A cardboard model f *ferrugineus* had produced "interest" in a *Cephalonomia.* She was then ested with a *turcicus* larva at the other end of the same experimental tube ut showed no "interest" in it. When the model and larva were placed together she attacked the larva after further examination of the model. The wo objects which separately were insufficiently stimulating became adequate vhen combined. As it was the larva which became the adequate stimulus it s possible that there is a tactile element which it provided.

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DISCUSSION

Mr. **Sweetman**: Does the percentage of parasitism increase with higher emperature?

Mr. **Finlayson**: It probably does.

Mr. **Vleugel**: Did you use fertilized or unfertilized females?

Mr. Finlayson: I took care to see that they were always fertilized.

Mr. **Colhoun**: 1) From what host insect were the parasites reared prior to commencing the Exp's? 2) Were the F2 generations reared from the different osts, exposed to each of the hosts; what was the result?

Mr. **Finlayson**: 1) *Laemophloeus ferrugineus.* 2) *Cephalonomia* reared on *L. minutus* for one generation show an increased tendency to attack that

species but the primary preference for *L. ferrugineus* is not surpassed.

Mr. **Théodoridès** : You have reported a protozoan parasite (*Mattesia*) from *Laemophloeus*. Do you think that individuals parasitized by the latter would be weakened and more readily attacked by *Cephalonomia*?

Mr. **Finlayson**: I do not think *Cephalonomia* can discriminate between parasitized and nonparasitized larvae. Larvae which are infected by *Mattesia* may be unable to struggle so well when attacked by *Cephalonomia*, but as very few healthy larvae escape once attacked, I do not think the state of the larvae is important.

RECENT WORK ON CYCLICAL BEHAVIOUR IN THE NEMATOCERA

by
P.F.MATTINGLY
London, England

The studies to be discussed first were carried out by the Yellow Fever Research Institute at Entebbe, Uganda and on a smaller scale by the Yellow Fever Research Institute at Lagos, Nigeria. Their object was to reveal something of the behaviour of forest mosquitoes in those areas, among them the vectors of sylvan yellow fever. Fig. 1a represents the biting cycle of *Anopheles gambiae* as we observed it in Nigeria. The method of procedure was to place Africans in pairs on the ground and on platforms at various heights in a forest tree. They remained there continuously for 24 hours at a time, changing from one platform to another every two hours. In order to avoid imposing any arbitrary pattern on our results in consequence of some personal factor such as variation in the attractiveness of individual Africans to mosquitoes this rotation was carried out in a random manner. The Africans caught mosquitoes on themselves and on oneanother and these mosquitoes were collected at exact one hour intervals and were subsequently identified and counted. The graph shows the numbers of *Anopheles gambiae* taken in 22 of these 24-hour catches. The total taken during each hour is expressed as a percentage of the whole catch, in this case just over 2500 mosquitoes, and the figures have been lumped into two-hourly totals in order to smooth out minor irregularities in the curve. It will be seen that biting activity is at a low level during the day but increases sharply at sunset, reaching a small peak shortly afterwards. It then starts to intensify and climbs steadily during the night, again rising to a sharp peak shortly before sunrise. After sunrise it falls rapidly to the daytime level. The technique employed is subject to criticism on account of the personal element involved but it is believed that this was largely eliminated by the method of shuffling the human bait and this belief is strengthened by comparing the curve obtained by similar methods in Uganda (Fig. 1b) which shows a close general resemblance. The curve from Uganda was based on a much larger number of catches and a total of more than 30,000 *gambiae* but such differences as do exist between the two curves seem to be due not so much to this as to the use of different time scales. In Nigeria we worked to Nigerian Standard Time and we only reduced our times to Local Mean Time, the true solar time for that particular locality, when the work was completed. In Uganda they worked to Local Mean Time from the first and in consequence their hourly samples were collected exactly on the hour whereas ours were collected at 15 minutes past the hour. Since the duration of peak activity is very short, perhaps of the order of 20 minutes, this 15 minutes difference is very important. Thus

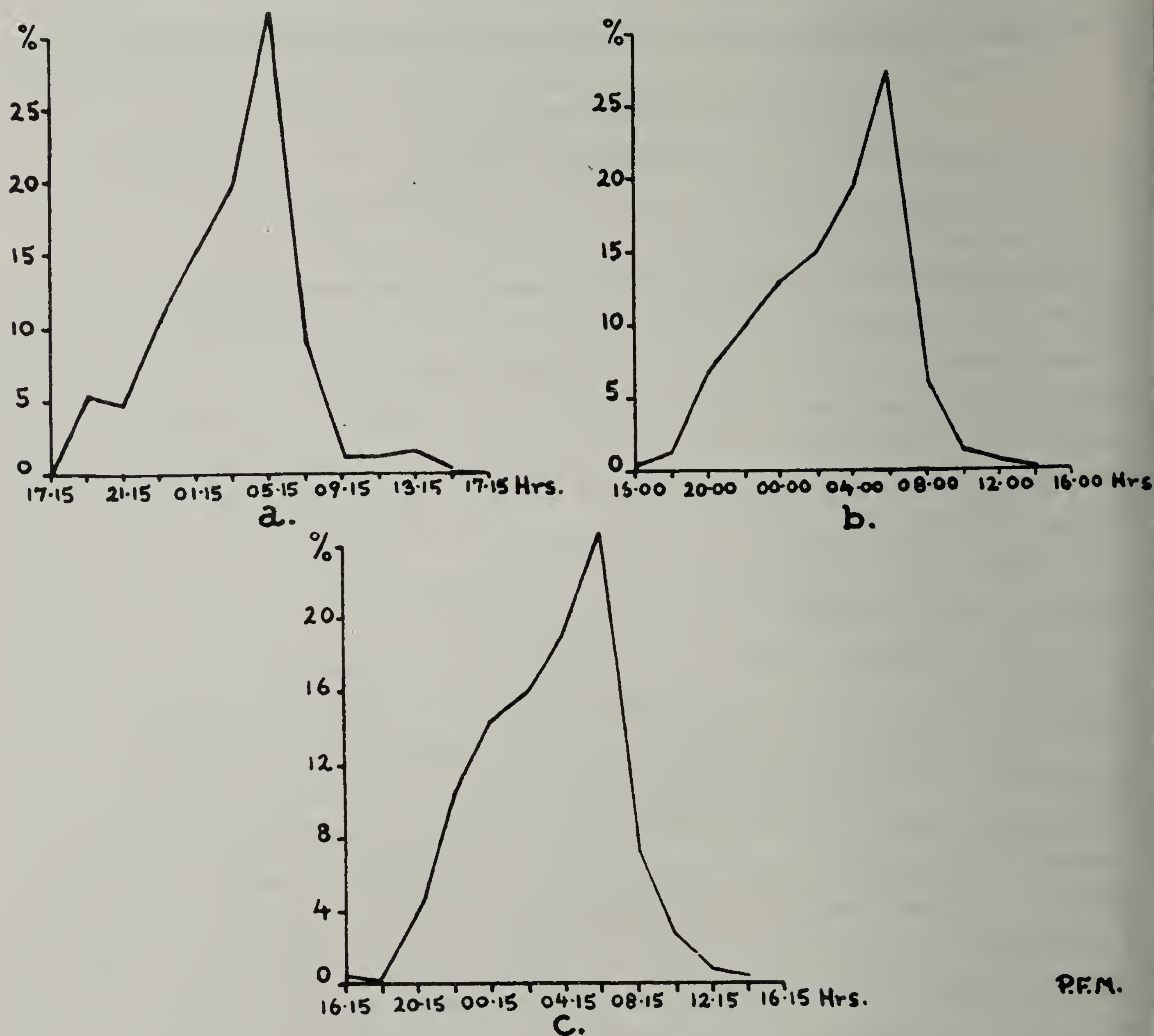


Fig. 1 *a.* Biting cycle of *A.gambiae* (Nigeria); *b.* Biting cycle of *A.gambiae* (Uganda); c. Biting cycle of *A.hargreavesi* (ground only).

it will be seen that the small evening peak shown by the curve from Nigeria is missing from the curve from Uganda. The explanation appears to be that in Uganda the hourly collections were made in the middle of this short peak so that it was shared more or less equally by two successive hours. Other small differences between the curves seem also to be due to this factor.

Turning to *Anopheles hargreavesi*, a related though very distinct species, it will be seen that at first sight the biting cycle seems very different (Fig. 2a). There appears to be a much sharper rise to the night-time level and biting is maintained at a more uniform level during the hours of darkness. On closer examination, however, it was found that these differences were due almost entirely to a small difference in the time of the morning peak and to the influence of vertical distribution. Both *gambiae* and *hargreavesi* bite mainly on the ground and on the lowest platform (50 % on the ground, 35 % at 22 ft. and the remaining 15 % on the two upper platforms at 40 ft. and 52 ft. respectively). In *gambiae* peak activity takes place before

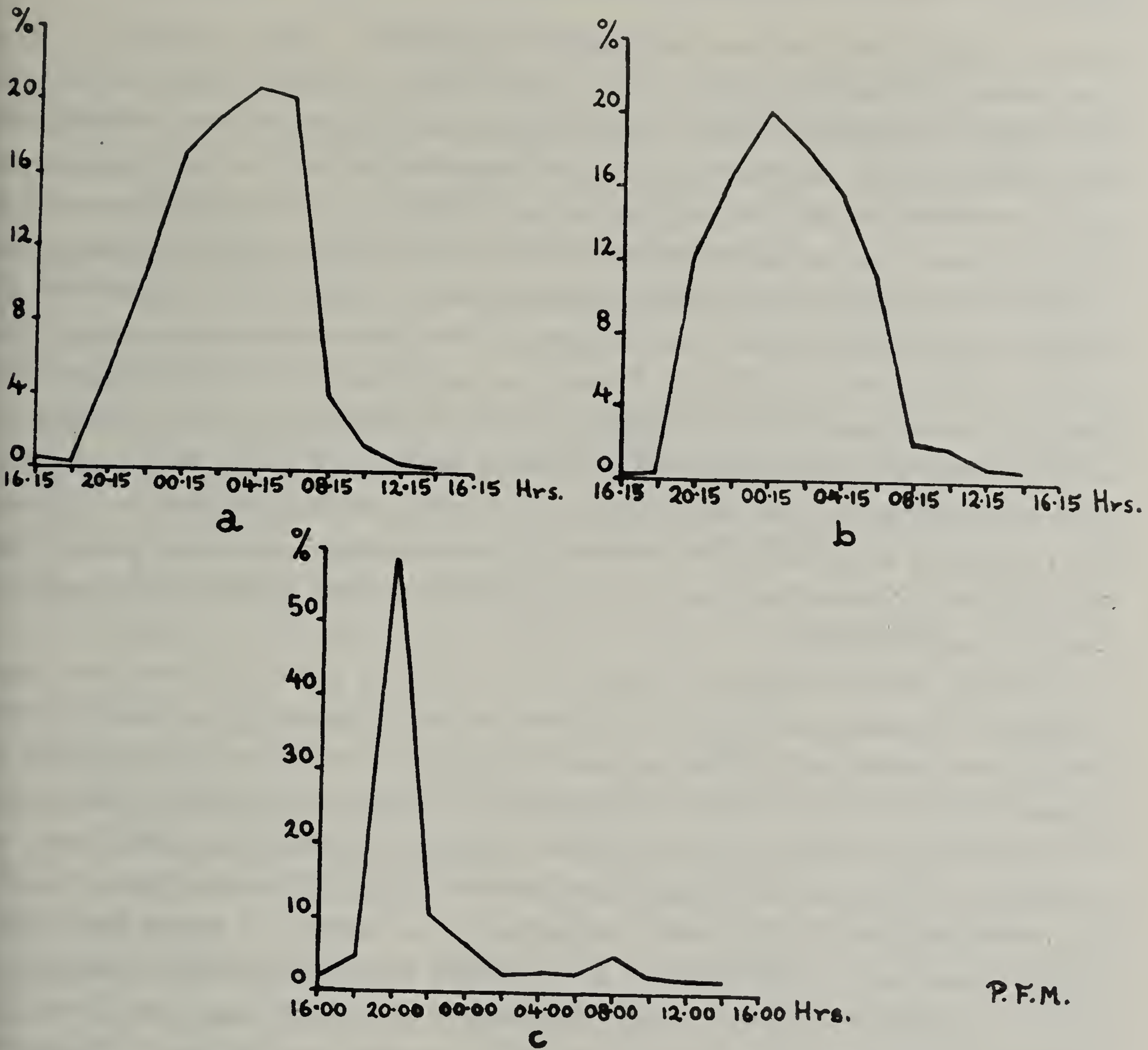


Fig. 2 *a.* Biting cycle of *A.hargreavesi* (All platforms combined); *b.* Biting cycle of *T.africanus; c.* Biting cycle of *Aë.africanus* (Uganda).

sunrise and all platforms contribute to it since the effect of bright light on the upper platforms is not yet felt. In *hargreavesi* peak activity takes place somewhat later at a time when biting is much depressed by this factor on the platforms. These do not therefore contribute their full quota and when the figures for all heights are combined the peak is completely masked. The true nature of the basic activity is thus seen only when a curve is drawn for the ground alone (Fig. 1c).

Among the Culicine mosquitoes *Aëdes africanus* showed a very distinct type of biting cycle with very marked peak activity during a short period after sunset followed by a rapid fall to the low level of activity maintained during the rest of the 24 hours (Fig. 2c). Other culicines seemed to show variations either on the *gambiae* or the *africanus* type of cycle although it was not always apparent on first examination that this was the case. A particularly good example is afforded by *Taeniorhynchus africanus.* The combined curve for this species (Fig. 2b) shows a peak in the middle of the night although the variation in the time of occurrence of this peak as

between individual catches was very considerable. This remained a most mysterious phenomenon until it was realised that a convex curve of the *gambiae* type if combined with its mirror image would give a curve of precisely the type found in *T. africanus*. On the hypothesis that in this species we have two sections of the population, one with an evening and one with a morning peak, the variations between the times of the resultant biting peaks in different catches are readily explained on the basis of a variation in the relative proportions of the two sections of the population. Most of the mosquitoes encountered in Nigeria showed an eocrepuscular type of rhythm even though in some cases the evening peak (as in *gambiae*) or the morning peak (as in *Aëdes africanus*) might be relatively very small and in this connection it is interesting to note that DOWNES, working on *Culicoides* in England, has been able to associate the evening and morning periods of peak activity with two different sections of the population, the gravid and non-gravid females respectively.

Swarming was not directly observed in Nigeria although there was some evidence of peak activity on the part of males of *Taeniorhynchus africanus*, *Aëdes flavicollis* and *Aëdes taylori* during the early part of the night. In Denmark, however, NIELSEN and GREVE, working mainly with *Aëdes cantans*, observed eocrepuscular rhythms closely comparable with those encountered in Nigeria. DOWNES also observed a similar bimodal type of activity among males of *Culicoides nubeculosus*. Among the many interesting observations made by NIELSEN and GREVE one which seems particularly significant concerns the relation of swarming to the meals of honeydew which are taken by the mosquitoes while resting in the grass during the daytime. Swarming activity in the evening begins with an ascent to the tree-tops above which most of the swarming takes place. It takes the form of a short period of intense activity of comparable duration to the periods of peak biting activity observed in Africa. After it is over the mosquitoes rest in the tree-tops and, in general, they then swarm again in the morning. After the breaking-up of the morning swarms they drift slowly to the ground and almost immediately afterwards are found gorged with honeydew. In view of the now well established fact that glycogen forms the main fuel utilised in insect flight and that insects allowed to fly to exhaustion can be rapidly revived by meals of sugar which are polymerised and mobilised as glycogen with astonishing rapidity it is difficult not to believe that these meals of honeydew furnish the energy source required for the intense activity of swarming. If this is so then a like argument would apply to the other blood-sucking mosquitoes studied in Africa. Certainly it is hard to believe that meals of animal protein could possibly furnish the glycogen required. This matter is now being investigated and should it prove that meals of plant sugar are as important for mosquitoes as they seem to be then attention will have to be focussed on an aspect of the life of these insects which hitherto has been quite largely ignored.

DISCUSSION

Mr. **Knight**: In connection with the speaker's suggestion that the peculiar iting curve found for *T. africanus* was due to the presence of more than one eak of activity, it was asked whether or not the collected specimens had een examined for age and for their condition of gravidness.

Mr. **Mattingly**: The biting material was collected for a virological study nd this necessitated immediate use of specimens and precluded the possibil-ty of further study.

Mr. **Sturte**: Did the speaker find any relationship between the time of warming and the time of feeding (taking a blood meal). *C. pipiens* begins o swarm even a little before sunset and ceases before it gets dark. *T. rich-ardii* does not begin swarming until it is practically dark and seems not to ake blood meals until about mid-night. Sylvan species seem to bite at all ours providing the victim is in a heavily shaded (semi-dark) part of the orest.

Mr. **Mattingly**: I now think that the term "biting cycle" as originally applied was probably a misnomer and that we were probably using biting merely as a means of revealing changes in the general activity of the mosquitoes. In his case swarming and biting might well show the same type of cyclical pattern. In the case of biting, however, this pattern would be due to an in-creased frequency of contact with the bait resulting from increased duration and frequency of flight and the urge to bite per se might be subject to diff-erent influences and might possess its own quite distinctive rhythm.

Mr. **Reid**: *A. maculatus* seems to have a biting peak between 10 p.m. at midnight in contrast to the peak with *A. gambiae* before dawn.

Mr. **Mattingly**: I should be inclined to suspect a double activity of the kind that I have postulated for *Taeniorhynchus africanus*, particularly if the peak biting time were found to vary from one catch to another.

Mr. **Vleugel**: In this country when camping out one is always bitten at dusk. During the night biting hardly occurs; the mosquitoes are resting in-side the tent but at dawn for a short while they become active again. Is such behaviour characteristic for a definite species or species group?

Mr. **Mattingly**: This seems to be a similar type of activity to that observ-ed by NIELSEN in *Aëdes cantans* and would probably be characteristic of other man-biting Palaearctic *Ochlerotatus*. It is the type of activity common-ly termed co-crepuscular because the periods of peak activity are associated with dawn and dusk.

A COMPARATIVE STUDY OF THE MATING BEHAVIOUR OF EIGHT LIPOSCELIS SPECIES

by

Edward BROADHEAD

Leeds, England

The family Liposcelidae of the Order Corrodentia comprises two distinct genera, *Embidopsocus* and *Liposcelis*. The mating behaviour has been investigated in *E. enderleini* and in the following eight *Liposcelis* species—*liparus terricolis, pubescens, subfuscus, entomophilus, paetus, paetulus* and *rufus*. The present communication is based on observations of 3 pairs of *E. enderleini* and 6-16 pairs of each of the *Liposcelis* species. In each case a male which had been isolated for several days was introduced into an observation cell with a virgin female. The period of courtship, that is the period between the first signs of male response to the female and copulation, is usually between 2 and 10 mins. Coitus lasts for 30 mins. to 1 hour. There is no correlation between duration of courtship and duration of coitus.

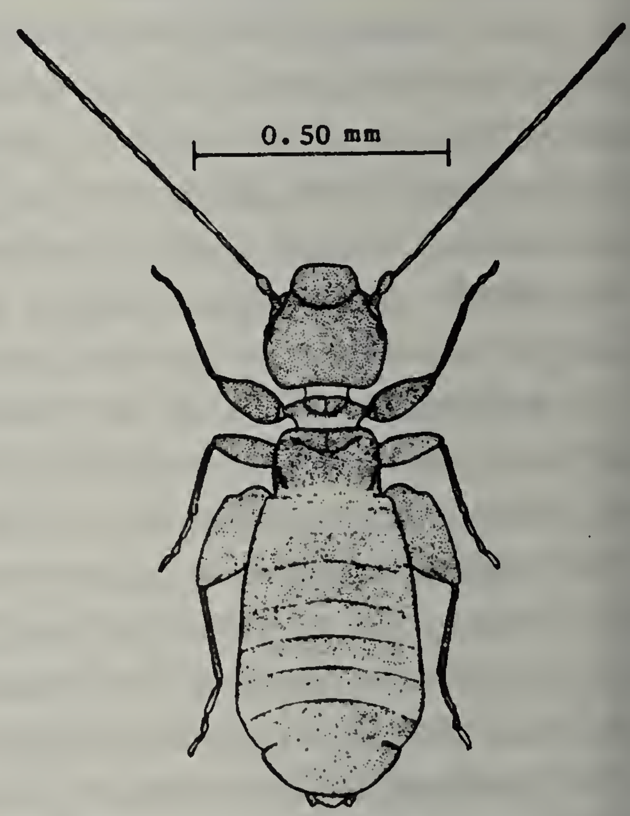


Fig. 1. *Liposcelis simulans* Broadhead. Adult female. (Reproduced by kind permission of the Royal Entomological Society of London.)

The species of *Liposcelis* (fig. 1) are all apterous in both sexes. Both male and female genitalia are remarkably uniform throughout the genus and the size differences between species are so small that there can exist no mechanical barrier to hybridization. Although their geographical distribution is unknown, five of the eight species studied are recorded from warehouses in Britain so that their ranges do now overlap. Mating behaviour is also very similar in these eight species but nevertheless reproductive isolation is complete. Immediately after introduction of a pair into an observation cell, both male and female walk round the cell until they accidentally touch each other or approach each other to within 2-3 mm. At this distance sensory contact appears to be established. This is probably olfactory. Sight cannot be involved since mating will take place in complete darkness. The male responds by vibrating his antennae very rapidly through an arc of 30^{o}-40^{o} for a few seconds, followed by short quick runs, stopping suddenly and vibrating his antennae again. The female responds to the antennal vibration of the male by vibrating her

antennae in a like manner and these vibrations are often continued more or less alternately by the two sexes for the period of courtship. There is some variation in the extent of the vibrations among the different species. In *L. paetus* for instance they often consist of little more than two or three quick flips. Considerable intraspecific variation does, however, occur in this respect. The fact that these vibrations in the two sexes are never concurrent suggests that they serve for mutual stimulation. Matings have been observed on several occasions in which the female has not vibrated her antennae and a few preliminary observations on pairs in which the flagellum of one partner had been removed indicates that antennal vibrations in either sex are not indispensable for successful mating. These vibrations are almost entirely restricted to the period of courtship and coitus. In only one case have antennal vibrations been observed in nymphs. This was a female nymph, probably last instar, in a thriving culture of *paetulus*. Many hundreds of nymphs have been observed at one time or another. Antennal vibrations appear to be characteristic of the genus *Liposcelis*. They did not occur in the three pairs of *Embidopsocus enderleini* examined, and no mention of them is made in descriptions in the literature of the mating behaviour of twelve other psocid species representing six families. During this period of courtship the male becomes very active. The very active clockwork-like nature of the running movements of the male is very noticeable in *terricolis* and *rufus*, is less marked but still conspicuous in *liparus* and *entomophilus*, but is not shown to the same extent in the other species. In *L. rufus* the male often runs for a short distance round the female, stops and vibrates his antennae and then carries out quick forward and backward jerking movements of his body without altering the position of his tarsi on the substratum. Such jerking movements of the body are characteristic also of *Embidopsocus enderleini*. There is also some variation within the species. While the period of courtship usually lasts for 2-10 mins., pairs consisting of virgin male and female have been observed on occasion to carry out this preliminary courtship for half an hour without successfully copulating at the end of this period. This cannot be attributed to „preference" or selection of one partner by the other since these same individuals when paired again a day or two later copulated within the normal period after introduction into the cell. Finally the male approaches the female from behind or from the side, runs over her completely in a forward direction and, when in front, makes a shuffling movement backwards beneath her so that both animals face in the same direction and in this position copulation is effected. There is some intraspecific variation in this procedure. In *L. paetus* for instance the male sometimes walks over the female, but more often he turns round after facing her and then moves backwards beneath her. This latter behaviour was also observed in *entomophilus* and this was the procedure in all the six pairs of *rufus* examined. In all matings observed the female appears to play an active part in accepting the male by raising up the anterior part of her body to allow him to move backwards

beneath her, and, either by slightly moving her position or by moving he legs, she appears to direct the male into the position suitable for coitus Probably also the opening of the female genital cavity by depressing th subgenital plate is essential for copulation. Shortly after copulation th male twists round through 180° so that the pair face in opposite direction during the greater part of coitus.

The mating behaviour of *Embidopsocus enderleini* is characterised by th absence of antennal vibrations (at most two or three quick flips of the an tennae by the female), by the forward and backward jerking movements c the body in the male (as in *L. rufus*), and by the fact that the male runs fo ward beneath the body of the female from behind. In this last feature onl does *E. enderleini* differ absolutely from the *Liposcelis* species.

The behaviour of the sexes was also observed in mixed pairings, 8-2 pairs of each of the following reciprocal pairings being investigated: L *liparus* x *entomophilus, L. entomophilus* x *terricolis, L. pubescens* x *sul fuscus, L. paetus* x *paetulus, L. liparus* x *rufus* and *E. enderleini* x *L. liparu* (2 pairs only). Copulation did not take place in any of these mixed pairs, bu the behaviour is worth recording. In all the mixed pairings of *Liposceli species*, the male, after chance physical contact with the female or clos proximity to her, responded by increased activity carrying out the quick run alternating with sudden stops and vibrations of the antennae, that is by th characteristic preliminary courtship behaviour. In only three types of mixe pairs (the reciprocal pairing of *entomophilus* with *terricolis* and *paetus* with *paetulus* ♂) did the female vibrate her antennae. In the pairing *L. liparus* and *entomophilus* ♂ the male attempted to move backwards under the femal and in one of the pairs observed succeeded in doing so. The female, how ever, reacted either by the rapid backward run which is the characteristi avoiding reaction of all *Liposcelis* species or by walking away. In the re ciprocal pairings of *pubescens* with *subfuscus*, no attempts were made b the male to make any physical contact with the female although the male usually vibrated their antennae. In the other pairings the male approache the female as if to continue the normal mating procedure but on first physic contact she either carried out the backward avoiding reaction or walke away. In the pair *E. enderleini* ♂ x *L. liparus* ♀, the male *enderleini* made few of the forward and backward jerking movements of the body characteris tic of the mating behaviour of this species but never attempted to walk fo wards beneath the ♀ *L. liparus*. No responses by either sex were observe in the reciprocal pairing, *enderleini* ♀ x *liparus* ♂.

In the genus *Liposcelis* then, the male is stimulated by females of oth *Liposcelis* species. Although the single pair observed of *E. enderleini* ♀ *L. liparus* ♂ is insufficient to allow any general statement, there would appe to be no specific, but perhaps only a generic recognition of the female b

the male. The initial male response, that is before antennal vibrations have begun, is probably olfactory, but once the male has been sexually stimulated, the subsequent courtship behaviour is not necessarily directed even towards a female. The failure of the mixed pairs to copulate depends then entirely on the female. The factors involved here are obscure. Recognition by the female of a male of her own species cannot be by sight. If antennal vibrations by the male are involved, these would have to be distinct, in frequency or in some other way, in all the different species. Successful copulation in two pairings between a female *entomophilus* and a male whose flagellum had been removed renders this unlikely. Touch or more likely, smell, is perhaps involved in recognition of the male.

DISCUSSION

Mr. **Richard**: Pendant la vibration antennaire, les insectes se touchent-ils réciproquement une partie quelconque du corps avec les antennes?

Mr. **Broadhead**: When antennal vibrations are being carried out by both sexes during courtship, the antennae of male and female do not touch, but very exceptionally male and female will remain for some time facing each other with antennae or even maxillary palps touching, during which time vibrations of the antennae may occur.

ON THE ORIENTATION OF BEMBEX ROSTRATA L.

by

J.J.A.VAN IERSEL

Leiden, Netherlands

In this preliminary communication, I shall report briefly some analytical investigations of the orientation of the diggerwasp, *Bembex rostrata*, in the vicinity of its nest.

Although the investigations are still in full progress, I shall describe some of the current results partly because they differ from the findings of TINBERGEN and his collaborators (1932, 1938) with *Philanthus triangulum* Fabr., and partly because we have developed a new experimental method.

TINBERGEN (1932) found that the orientation of *Philanthus* is of an optical nature: the wasp is guided by visual landmarks in returning to its nest. Furthermore, he concluded, on the basis of numerous experiments, that a substrate rich in contrast bears much more effective landmarks than does a uniform one. Also, three-dimensional objects have a strong landmark value; height is an especially active mark of identification. Therefore, a pine cone represents an optimal beacon for *Philanthus*, for it has both three-dimensionality and indentation.

In obtaining these results, the wasp is trained on an artificial landmark system consisting of two components, differing from each other in only one property. A choice-experiment offering simultaneously two landmark systems, each having only one of the two components, informs us about the landmark value of the property concerned.

It appears that the training of *Bembex* is much more difficult than that of *Philanthus*. We succeeded only after destruction of the nest surroundings and placing the training landmarks on a barren surface, thus making them artificially the only usable ones; even so, the training on each situation required a long time.

This points to the idea that *Bembex* normally uses a highly complex pattern of beacons and is not greatly disturbed by or obliged to use the objects newly added as training landmarks. It is also possible that *Bembex* may normally use a pattern of optical points located far from the nest and is not disturbed at all by artificial landmarks placed closely around the nest.

Still, it is possible to analyse the characteristics of the optical objects with regard to their landmark value. One observation was the starting point for our new experimental method. A *Bembex* which has a well-established knowledge of the nest surroundings never hesitates when landing on the nest patch. With lightning speed it lands and enters its nest with the captured fly. Also, in most cases it does not show an orientation flight when again leaving the nest, after quickly closing the entrance. The animal is able to find its nest from all sides and it also leaves in any direction without re-

:ientation. (I distinguish re-orientation from orientation flights in order to ıdicate that the former are performed only during the parental phase and not : all during the nest-digging phase. The observations mentioned here were ade with wasps which were bringing in flies for their larvae.)

The average hesitation (or desorientation, as we called it) of more than 50 observations was 0.0 sec., and the average duration of the re-orientation he so-called re-orientation time, or R.O.T.) only amounted to 0.3 seconds.

There are some circumstances in which a *Bembex* obviously is forced to ake re-orientation flights to a much greater extent after or during the closıg of the nest. So, for instance, a connection exists between the nest-cleanıg activity and the tendency towards re-orientation. A *Bembex*, which af-ɛr bringing in a fly cleans the nest very intensively, shows in most cases uring this activity several orientation flights, although no previous desrientation is observed. An average of 4.8 sec. is obtained from 15 observtions. These cases were not included in the calculations of the averages sed here.

Now it appears that a *Bembex* coming home and being desorientated by omething placed in the neighbourhood of its nest, shows a remarkable inrease in R.O.T., even if the disturbing object is taken away during the ime the wasp stays in the chamber.

If the animal does not find the nest entrance at all, the disturbing object s removed after two minutes of desorientation. In by far the most cases, he wasp then finds the nest immediately and also reorients itself after :losing it again. Obviously the state of being desorientated evokes a renewed ›rientation, even over an already known situation.

Using disturbing objects with different properties, we find that the average l.O.T. also differs. Therefore, a simple method is available to analyse the andmark-value of the properties of an object, for it seems logical to supose that the higher the landmark-value of an object (due to certain properies), the stronger is the desorientation that can be evoked by that object, ısed now as a disturbance in an already known situation, and also the stronger the re-orientation which will be released by the preceding desrientation.

The method used here may be briefly represented by the following scheme: lesorientation by a strange object (maximally of two minutes) ----> entering he nest (removing of the object) ---> re-orientation over the undisturbed ituation. The disturbing object always is placed parallel to the nest axis ıt a distance of two cm. from the nest entrance in such a way that half of he object stands or lies before the entrance (fig. 1). All the disturbing obects are painted dully black in order to limit a possible disturbance by hiny surfaces. In order to avoid another pitfall, i.e. an additional effect of he shadow, especially when cast by higher boxes, the objects are placed ılternately at the right or left side of the nest, in relation to the place of the sun.

The animals with which these experiments were carried out had not been

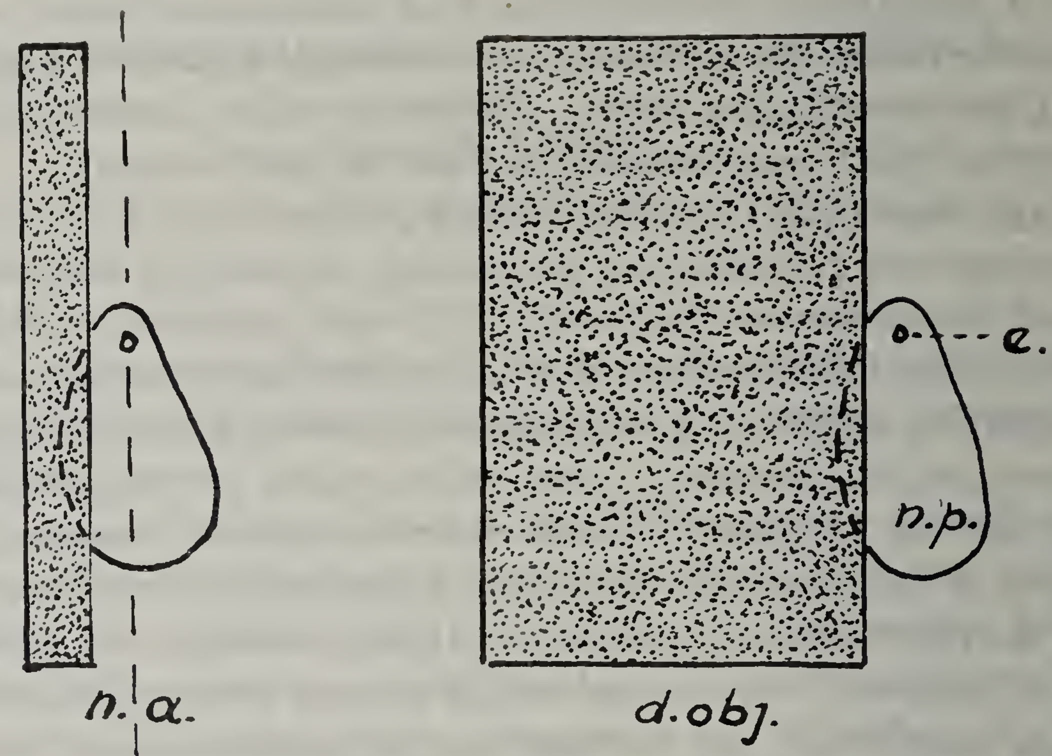


Fig. 1. Placing of a disturbing object: n.a. is nestaxis; e is entrance; n.p. is nest-patch; d.obj. is disturbing object.

used shortly before, because it appeared very soon that when one animal is disturbed several times in succession, the R.O.T. is influenced by a learning-process. The wasp learns the object during the so-called desorientation time. (This suggests a possible reason why no close correlation could be found between the desorientation time and the R.O.T.) It appeared, however, that after one day of rest an animal could be used again. Finally, only wasps carrying in flies were used in the tests.

Considering only the average R.O.T., a remarkable point results : no correlation could be found with the height of the disturbing objects, with their width, with the content of the different objects used, or with the upper-surface, i.e. the area covered by the disturbing object projected on the bottom. The re-orientation times are correlated only with the *total surface* (table 1).

However, a close correlation between total surface and increase in R.O.T. exists only to a certain width. So e.g. sheets of cardboard with a constant length and a height of approximately 0 cm., but with increasing width effectuate R.O.Times arranged along the so-called "Height = 0 line". (see graph and table 2.) It is obvious that an optimal width exists. A sheet with a larger width produces a slighter desorientation and subsequently a shorter re-orientation.

But it seems best to say something about this so-called "H = 0 line" after discussing the rising branch of the graph, which demonstrates that a close correlation indeed exists between total surface and R.O.T.

It is remarkable that *Bembex* uses the total surface of a landmark as a key-characteristic of it, and that an object is stamped as a favourable landmark by a *large* total surface. The wasp must have the ability to estimate

Table 1

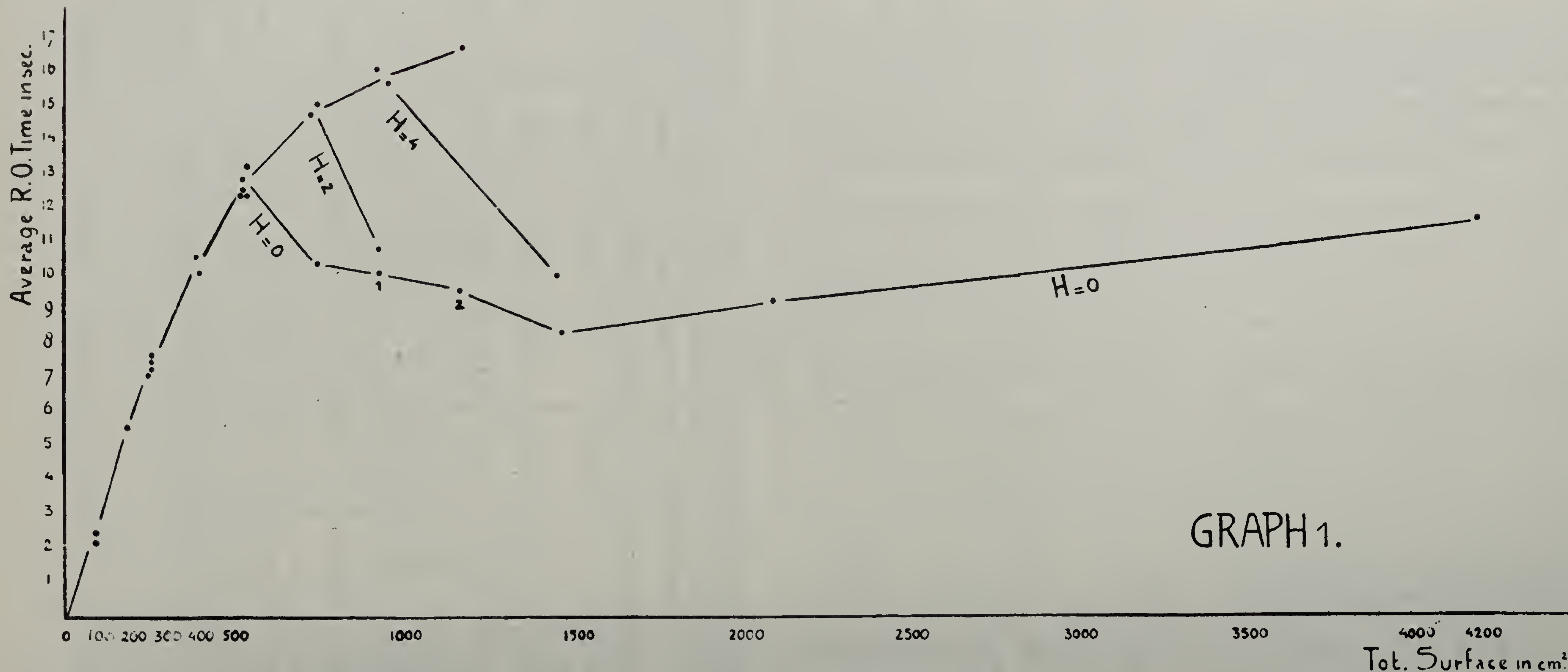
Relation between type of disturbing object and Average Re-Orientation Time

Disturb. Object	Length	Height	Width	Upper-Surface	Content	Total Surface	Av. of R.O.Time	Number of exp.
Hor. sheet	30	0	3	90	9	90	2.2	39
Vert. sheet	30	1.5	0	0	9	90	2.5	40
Hor. sheet	30	0	6	180	18	180	5.6	30
Box	30	2	1.8	54	61	182	5.6	23
Hor. sheet	30	0	8.5	255	25.5	255	7.6	28
Box	30	2	4	120	240	256	7.7	65
Box	30	3	1.8	54	162	245	7.2	49
Vert. sheet	30	4	0.5	15	60	256	7.3	30
Hor. sheet	30	0	13	390	390	390	10.6	35
Box	30	5	2.5	75	750	400	10.1	37
Hor. sheet	30	0	18	540	54	540	12.4	35
Box	30	2	12	360	720	528	12.4	29
Box	30	6	4	120	720	528	12.9	28
Box	30	8	1	30	240	528	12.5	28
Vert. sheet	30	9	0	3	27	540	13.3	29
Box	30	2	18	540	1080	732	14.8	34
Box	30	10	3	90	900	750	15.1	31
Box	30	4	18	540	2160	924	16.1	33
Box	30	10.5	6.5	195	1950	960	15.7	32
Box	30	14.7	5	150	2205	1180	16.8	31

Table 2

Average R.O.Times obtained by disturbing with sheets of increasing width

Disturb. Object	Length	Height	Width	Total Surface	Average R.O.T.	Number of exp.
Hor. sheet	30	0	3	90	2.2	39
Hor. sheet	30	0	6	180	5.6	30
Hor. sheet	30	0	8.5	255	7.6	28
Hor. sheet	30	0	13	390	10.6	35
Hor. sheet	30	0	18	540	12.4	35
Hor. sheet	30	0	25	750	10.4	33
Hor. sheet	30	0	31	930	10.1	41
Hor. sheet	30	0	39	1170	9.6	34
Hor. sheet	30	0	49	1470	8.3	36
Hor. sheet	30	0	70	2100	9.3	35
Hor. sheet	30	0	140	4200	11.8	28
Box	30	2	18	924	10.8	38
Box	30	4	18	1456	10.0	35



Graph 1: Relation between average R.O.T. in sec. and total surface in cm^2 of the disturbing objects. Each point represents a disturbing object. For explanation see text.

the total surface, although it sees it from one side while flying home. This resembles our own peculiarity in having an idea about the moon as a globular thing, although we have never looked at the back of it. During digging a new nest, the wasp gets an opportunity to estimate the total surface of the potential landmarks in the neighbourhood, for the orientation flights are made then in all directions.

Further, it was quite astonishing for me to find that the total surface was a key-characteristic. The expectation was that *Bembex* would use height still more than *Philanthus*, because *Bembex* always approaches the nest at a small distance above the ground, not more than 50 cm.; *Philanthus*, on the other hand, draws nearer to its nest at more than 2 or 3 metres, hovers at a point exactly above the nest and after spotting the right place lands slowly descending on it. It looked reasonable to suppose that a low-flying wasp would use height more than a "high-flyer".

It may be that to explain this fact we have to look for the difference in speed with which both species fly. *Bembex* always flies very fast with her fly, as opposed to *Philanthus*, which in relation to *Bembex* so to say "creeps" over the plain while carrying a bee. It may be that the *quick* succession of dark-light in the ommata represents a key-characteristic for a fast-speed animal and that the total surface of an object gives the best results in this respect. Till now no possibility has been found to test this hypothesis.

Let me now consider and discuss the so-called "H = 0 line". Apart from the normal increase of R.O.T. correlated with an increase of total surface, that means in the case of flat sheets with an increase of width (because length and height are constant), there are three facts in the "H = 0 line", that deserve our attention.

1) The rather sudden decrease of the R.O.T., if the width of the sheet surpasses the optimal value (18 cm.). Although the following sheet only has a width of 25 cm. the R.O.T. decreases from 12.4 sec. till 10.4 sec.

The fact that the 25 cm. sheet does not effectuate a *higher* R.O.T. points to the idea that beyond a certain zone no extra-desorientation and subsequently no longer reorientation can be evoked; that means that Bembex uses for its proximate orientation only a small girdle around the nest. A disturbance beyond this part is not possible, because the wasp does not use the potential landmarks present there at all. With this idea in mind, a reorientation time of the same duration as obtained with the optimal sheet would be expected in spite of an increasing width of the sheets.

But how to explain a decrease?

Comparing the sheet with an optimal width with a broader one it may be possible that the second contrast-line b, parallel to the nest axis (see fig. 2) does not play a rôle in the case of the wider sheet, because *Bembex* does not use the part beyond the 18 cm. Therefore the larger sheet offers not so much disturbance in the situation known already by the wasp as the smaller one.

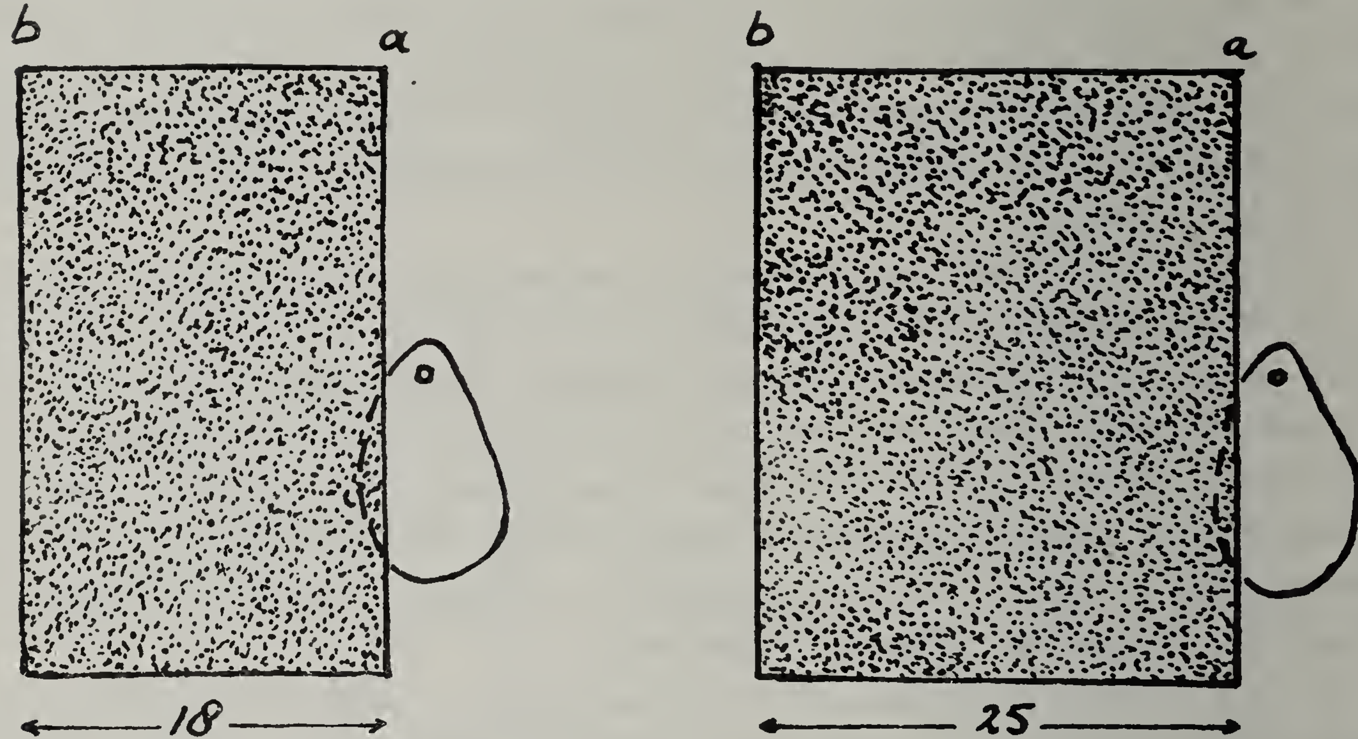


Fig. 2. *a* is first contrast line; *b* is second contrast line. Explanation in text.

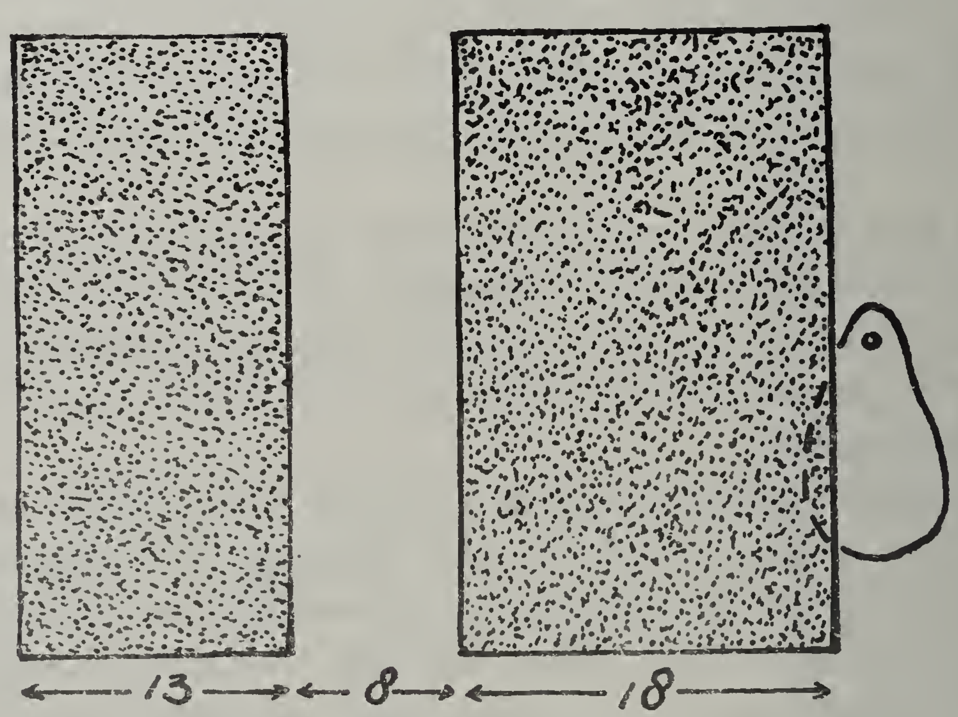


Fig. 3. Explanation in text.

To test this hypothesis, the following experiment has been carried out. We offered *Bembex* a system of two sheets, one having a width of 18 cm., i.e. the optimal value, and the second one of 13.0 cm.; the space between them was 8 cm. (fig. 3). Therefore, if *Bembex* reacts only in accordance with the total amount of covered bottom, this system must give the same value as a sheet of 930 cm^2 (R.O.T. of 10.1, point 1 in the graph.). However, if the wasp optically forms only one system from both sheets with the space between, the same value as obtained with a sheet of 1170 cm^2 (R.O.T. of 9.6, point 2 in the graph) has to appear, and if it reacts only to the first sheet, without any additional effect of the second one, the same value as for the optimal sheet (R.O.T. 12.4) must result.

The supposition was that the system would give the same value as obained with the optimal sheet. The experiment confirmed this: the value for he system of sheets appears to be 13.1 seconds.

Therefore, it has been proven that the sheet with the larger width (25 cm.) ffectuates a decrease of reorientation, because of the fact that only three ines of contrast remain. The fourth one does not play a rôle, because the art of the sheet beyond the 18 cm. does not cover a part of the normally sed landmark system.

We found also for the height of 2 and 4 cm. the same optimal width and he same sudden decrease in R.O.T. upon making the width larger (see able 2 and graph 1).

2) Providing this explanation is true, we have to expect that sheets of till larger width than 25 cm. show the same decrease in R.O.T., that means o further decrease could be expected. Nevertheless the decrease continues, hough slowly (see graph 1).

3) On the other hand a slow increase appears again after exceeding a ertain width (about 60 cm.).

Both these facts we try to cover by one hypothesis, n.l.: the stronger the andmark system around the nest is disturbed on one point, the more *Bembex* vill use the remaining undisturbed part of the system or even a new system f optical points outside the proximate neighbourhood of the nest, the latter ossibly in combination with the first system. Therefore in spite of a larger heet the re-orientation time would decrease, because of a switch-over to ndisturbed landmarks. Using however larger and larger sheets even this econd outer system is attacked. Therefore again an increase in R.O.T. has o appear. ***Bembex*** so to say would use girdles of orientation-marks around he nest.

We have one argument that ***Bembex*** does use the undisturbed side of the estsurroundings and that it uses it less the larger the sheet. Disturbing n.l. with sheets on either side of the nest we found that using sheets of a small width a strong increase in R.O.T. appears as compared with a onesided disturbance (see table 3). This increase, however, decreases again, roportionally calculated, the wider the sheets used, although the area covered grows more and more.

Table 3

The effect of a disturbance on both sides of the nest with sheets of increasing width

Disturb. Object	Sheet on one side		Sheets on both sides		% increase
	Average R.O.T.	Number of exp.	Average R.O.T.	Number of exp.	
Hor.sheet	2.2	39	10.7	34	486
Hor.sheet	5.6	30	15.6	35	279
Hor.sheet	12.4	35	19.1	31	154
Hor.sheet	10.1	41	13.6	29	134
Hor.sheet	9.6	34	13.5	36	
Hor.sheet	9.3	55	14.2	33	

Therefore *Bembex* uses the remaining part of the nest surroundings, for in all cases the double-sided disturbance results in a longer R.O.T. But it does not use it in an increasing degree. The wasp switches over to another system, as is indicated also by the fact that a *constant* R.O.T. appears in spite of large sheets on either side of the nest, as opposed to the slow decrease in the case of a one-sided disturbance. Although the wasp, one-sidedly disturbed, uses the remaining part it uses it less and less. It may be that the slow increase in R.O.T. after disturbing with very large sheets double-sidedly, indicates that the second system on both sides is attacked.

We know from other observations (BEUSEKOM 1946, 1948), that *Philanthus* coming from the plain flies from one landmark system to another successively. *Bembex* does the same. Now I think the following idea will be right. A *Bembex* chooses the girdles of orientation marks in such a way, that, arriving at one system, it is able to see the following one. The distance between the girdles becomes smaller and smaller, because the wasp must be able to distinguish the more and more detailed landmarks of the following system. Arriving at the last girdle before the nest it looks for the landmarks in the proximate neighbourhood of the nest. The bottom characteristics between the systems are of no or only little importance for the wasp. It seems sufficient to learn only some girdles while digging a new nest, leaving out possible marks in between. With a minimum effort the wasp gets the necessary knowledge for finding back its nest.

The whole type of orientation resembles much our own way of finding back our path, for having fixated a point in front of us we have no interest in the objects with potential landmark-value present between us and the fixated point.

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DISCUSSION

Mr. **Baerends**: Mr. VAN IERSEL stressed the point that from his experiments it appears that height is of no great importance in the nestorientation of *Bembex*, whereas TINBERGEN in *Philanthus* showed height to be the dominating factor. Now TINBERGEN was using another technique than Mr. VAN IERSEL, a fact we may not overlook. Has any attempt been made already to find out if the difference of attack on the problem plays a rôle.

Mr. **van Iersel**: Yes, it has been done. We trained *Bembex* on a system of landmarks composing of half globes of a constant total surface and fla

circular plaques of varying total surface. With the aid of choice-experiments, it has been found that *Bembex* chooses equally both components if the total surface of the plaques is approximately the same as that of the globes; this is in striking contrast with the results obtained by TINBERGEN & KRUYT (1938).

Mr. **Richards**: Is it not necessary to prove that the reaction of *Bembex* to black objects is in fact an orientation reaction?

Mr. **van Iersel**: Yes, and it has been done in the following way. A *Bembex* is repeatedly disturbed with a ring (with a half circular section) placed, let us say, at the left side of the nest at a distance, of two centimeters. During the supposed reorientation time, however, the ring is put at the right side. After several times the ring is laid around the nest. *Bembex* coming back from the plain searches now for the nest at the right side of the ring; that means during the reorientation flight it has learned that the nest entrance must be at that place.

Mr. **Carthy**: Does the effect of the two small plaques placed on either side of the nest equal the effect caused by a single plaque of the same total surface as both plaques, placed on one side of the nest?

Mr. **van Iersel**: No, the double-sided disturbance evokes a stronger reorientation. E.g. a plaque of 180 cm^2, placed on one side, results in a R.O.T. of 10.6 sec., whereas two plaques of each the half surface, but lying on either side of the nest give a R.O.T. of 15.6 sec. This may be due to the fact, that an attack on several points in a "Gestalt" acts stronger than an attack on one point. Or it may be, that the increase in length of the contrast line in the case of the two plaques causes the increase in R.O.T.

UNIDIRECTIONAL MOVEMENT IN MIGRATING LOCUSTS

by
J.S.KENNEDY
Cambridge, England

The more or less unidirectional movement of various migrating animals, be they birds or butterflies, lemmings or locusts, is one of the long-standing wonders of animal behaviour. In other words it is one of those facts which is often described, even by observers, in such a way as to awe the hearer rather than stimulate him to objective analysis. Even with locusts, about which a relatively enormous amount of information has been collected, it was possible for certain specialists (GUNN et al., 1948) to say, quite recently: "The plain fact is these gregarious locusts migrate in swarms, and nothing is known of the causes." I do not think the outlook is quite as barren as that, but must warn you that what follows still awaits, in great part, proper experimental analysis and proof. A full discussion of the subject of which this is only a summary, will be found in KENNEDY (1951).

As pictured by non-specialists and by some specialists, migratory behaviour in the larger animals including locusts, consists essentially of steady and unwavering movement over long distances. One recalls vivid expressions like "inexorable" or "remorseless progress" and WILLIAMS (1949), for example, has said that one " 'compass' direction can be kept up hour by hour and day by day by a single insect." With that picture in mind, it has seemed necessary to look for guiding forces that could act equally well over long as over short distances. That has meant looking for as yet unknown kinds of reaction to as yet unidentified external forces, and even to postulating some mysterious innate sense of direction. For if the migrant does indeed direct itself independently of the obvious features of its immediate environment, then all the well known kinds of orientation reaction have to be set aside as irrelevant to the problem.

Now the first point that emerges from the work on locusts is that, while the notion of "inexorable progress" contains a good deal of truth with respect to the activity of these insects, it is far from true of their direction. The locomotory activity of migrants is not by any means continuous, but it is indeed extraordinarily persistent. All else in their behaviour seems more or less subordinated to it. But fixity of direction comes a very poor second. Whether one looks directly at single insects or swarms, or indirectly at whole populations of swarms on the map, changeability of direction strikes one forcibly. The main thing is not going straight, but going – locomotion; as is readily demonstrable in the laboratory where locust nymphs will often "migrate" for hours on end, going round and round in a small cage. (ELLIS, (1951)).

Nevertheless, a measure of directional regularity there is, and its causes

are our present problem. The important thing to notice here is that this directional consistency is not of one, but of two, distinct kinds: two orders, so to speak, of regularity, one superimposed on the other. When we make direct observations on single flying swarms or hopper bands in the field, we cannot of course follow them very far. But we can study them closely in relation to the immediate environment, and it is here that we notice a striking degree of stability of direction. The path of the migrant is noticeably "straightened out" as WILLIAMS (1949) has aptly put it. But the directions noted during such observations change from time to time, and are by no means a safe guide to the direction in which the given swarm will be found to have gone after a day or so. Most of our information about the direction of long-range movements is composed of inferences drawn from maps upon which all reports of swarms are marked by place and date. This kind of information is now very extensive and much of it has been very carefully analysed (e.g. WALOFF (1946)). It leaves no doubt that long-range movements are not unanimous, steady drives in one direction, but rather resultant trends, due to a certain bias developing among a complex of movements in a variety of directions.

It follows that long-range movements are not more linear extensions of the relatively steady, short ones we see, and nothing will be gained by trying to find a common explanation for these two kinds of directional regularity. We have one problem in the steadiness of courses as directly observed in single insects or swarms, to be studied in relation to weather and topography: a behavioural problem in the strict sense. We have another separate problem in the patterns of long-range movement among large numbers of swarms in relation to climate and geography: something more in the nature of an ecological problem.

Here we shall consider mainly the first problem. There exists now plenty of evidence that the migrants' orientation is by no means independent of stimuli coming from their immediate environment. They do, it is true, seem to be relatively indifferent to some kinds of stimuli. Thus when migration is slackening off in the evening, one often sees individuals turn aside towards single trees, etc., along their flight route and alight on them, as other, non-migrant insects do. But in full flight they press ahead without reacting to such features of their route, unless one lies straight in front, when they dodge, and resume their old direction again as soon as they are clear of the obstacle. In other words the behaviour complex of the migrant involves much more than the muscular activity of locomotion. With that there goes an adjustment of sensory physiology, or reactivity, which involves suppressing reactions readily evoked in non-migrants but which would put a stop to the migrant's persistent locomotion. To be more precise, therefore, one should use some such term as locomotory "drive" to describe the basic feature of the behaviour of migrants. The locomotion itself is merely one aspect or outcome of this whole peculiar neuro-physiological state of the insect.

But this "indifference" of migrants to their environment is only relative, as can be seen from the fact that they do finally dodge an obstacle. They

do not go on until they hit it. When the environment of the migrant changes sufficiently, in a variety of ways, the insect very clearly does react, and these reactions include orientation reactions. I will mention briefly the known or suspected reactions of this sort.

A light compass reaction to the *sun* has been demonstrated in hoppers of the Desert Locust, *Schistocerca gregaria* Forsk. (KENNEDY, 1945). If one changes the sun's position experimentally, with a mirror, the hoppers change their direction correspondingly. In nature of course the sun's position changes only very slowly, and this reaction presumably has the effect not of provoking but of restricting deviation by the insect. If, as a result of the insect swerving, the sun moves to a new position in its eye, the insect turns in such a way as to restore the sun's image to the old position in its eye. In thus regulating or stabilizing the sun's position in its eye, it automatically stabilizes its own direction.

Reactions to fellow-individuals, apparently also visual, have been observed in both hoppers and adults of various locusts. Here again, the reaction can have the effect of deviating the insects' path, for example when a thin stream of migrants meets a thicker one at an angle and the former is forced into the direction of the latter. But in the ordinary way when we have a single mass of moving insects, the effect of the reaction is not to provoke but to minimize deviations by individuals: the same thing can be seen in a flock of sheep, and is famous for its fatal consequences in a herd of Gadarene swine. The result is to stabilize the direction of the individual and so to endow the whole mass with what has been called gregarious inertia.

Reactions to the flow of air over mechanically-sensitive hairs on the head have been demonstrated in adult *Locusta* as WEIS-FOGH (1949) first described at the Stockholm Congress. Experimentally, one can arrange an air current to strike a suspended flying insect head-on and then switch the current to an oblique direction, whereupon the insect turns into the new direction of flow. In free flight, when the insect creates its own head-on flow so long as it flies straight, a swerve will cause a momentary oblique flow, so that this reaction too can serve to correct deviations.

The physical features of the immediate landscape – bushes, trees, banks, etc. – have both mechanical and visual effects on hoppers and visual effects on adults. The range of possible situations is so great here that these reactions are perhaps the most illuminating of all. But I will only say that here, too, reactions of the same essential kind can produce either sudden deviations, or continuous deviations, or rectilinear movement, in parallel with the arrangement of the external objects.

Lastly, a variety of circumstantial evidence, but still without direct proof, points to the conclusion that air flow also provides optical stimuli to which migrants react. Air being the adult locust's medium, its flow causes *drift*, that is, a component in the insect's displacement over the ground which is not due to the insect's own exertions and orientation. The circumstantial evidence suggests that this apparent movement of the background, due to the

nd carrying the insect over it, evokes optical compensatory responses the insect. These responses appear once more to be of a regulatory, stab-zing character in that they tend to restore the kind of movement across ; eyes which the insect experiences as a result of its own cruising flight ertions at a certain moderate height when there is no wind: that is, front-back movement of images at a certain moderate rate. That seems to require ienting against the wind when it is not too strong and the insects are low. ickward drift owing to too strong a head wind produces image movement om back to front instead of the other way, and that seems to evoke partic-arly powerful responses, which may involve actual settling, or turning ide until there is no backward component in the insect's track, or often turning right round and flying with the wind.

This list of reactions which determine orientation is not likely to be haustive, but I think it is long enough to dispose of the idea that straight-rward movement is a special problem, totally unconnected with the react-ns involved when deviations occur. To the limited extent that migrants do ld a steady course at all, we may attribute this with some assurance to the mporary lack of gross changes in their environment, so that their behav-ur is for the time being dominated by the more unchanging features of it, ch as the sun, fellow individuals or a steady wind. In that situation their gulatory reactions come into play mainly to correct their own waverings, r only these cause changes in their sensory relations with an unchanging vironment, and steady movement in one direction is the outcome.

One may say, therefore, that the migrant is – not deliberately of course, t in effect – always moving in such a way as to keep its sensed environ-ent as constant as is compatible with its own continued movement. Neither e reactions it displays, nor the fact that these serve a generally regulatory ıction, are new or peculiar to migrants. All we know to be new is their comotory "drive". Without, again, ascribing any wishes to the insect but eaking only of effective behaviour, we might say that the tendency to go raight is simply the insect's means of solving an old biological problem a new context: the problem of sensory stabilization in the context of rsistent locomotion.

There is space only for a brief reference to the second problem which was sed: how the patterns of long-range movement are determined, on a season- and geographical scale. Here we are much further from a proven solution, d all I can do is put forward a theory for future testing. Analysis of such ge scale migration-patterns, particularly by RAO (1942) and WALOFF 946), has shown fairly conclusively that the key influence here is the wind, hough long-range movements are not always with or against the prevailing nd. Since the air is the adult migrant locust's medium, the wind represents second means by which locusts can be displaced over the ground, the st means being, of course, the locust's own flight exertions. And since locust's responses to wind, as to other external changes, tend to minim- the sensory changes the wind creates, they tend also to minimize the

wind's transporting action – and so to keep the locust's displacement unde its own control, so to say. That means to keep it up-wind. If, on the othe hand, the locust loses control partially or wholly, its displacement wil obviously tend to be down-wind. Now, third factors can determine the fina outcome of this rivalry between wind and insect with respect to the insect's displacement. For example, if reactions to wind are mainly visual, as believe, then it follows that the regulatory reactions will cease when th insect is too far above the ground, for then the apparent movement of groun objects will be too slow to be noticed. The presence or absence of therma up-currents, depending on the amount of cloud, among other things, coul thus determine the resultant direction of a long-range movement. Other fac tors can play a similar indirect determining role, and since they, and th wind, and the condition of the locusts, all vary widely but according to definite pattern in the field, there does seem to be some hope here of ex plaining eventually that particular kind of order-out-of-chaos which we observ in the patterns of long-range locust migration.

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DISCUSSION

Miss **Waloff**: Studies of factors affecting the displacements of swarm of *Schistocerca gregaria* Forsk. have been made in East Africa, jointly b Dr. R.C.RAINEY of Desert Locust Survey, Nairobi, and myself (WALOFF, Z and R.C.RAINEY - Anti-Locust Bull., 9, London, 1951). With regard to fligh in winds in excess of locusts' flying speed, our observations agree wit Dr. KENNEDY's findings that on experiencing backward drift low-flyin locusts either settle or turn down-wind. As to flight in lighter winds, mos observations on orientation of flying swarms in relation to wind have bee made by mobile observers, whose progress was often handicapped by diff icult country or absence of roads. The data obtained in this manner ar inevitably biased in favour of slow-moving up-wind flying swarms, and th preponderance of up-wind flights among them cannot be considered as reliabl evidence of a preference to fly up-wind, such as has been postulated b Dr. KENNEDY. Such records contain an appreciable proportion of across an

down-wind flights of low-flying swarms in winds below the locusts' flying speed, and indicate that in such conditions locusts may fly either up, or across, or down wind.

On the other hand, wind may play an important part in determining the orientation at the time of take-off, and all the swarms which we saw leaving their roosting sites in light winds did so in a general up-wind direction. This probably arises from an aerodynamic necessity, for the flight of locusts, like that of all flying machines, would be facilitated by the flow of air in an anterio-posterior direction over their wings. The mechanism by which locusts can orientate into wind prior to take off is provided by the aerodynamic sense organ described by WEIS-FOGH (Nature, 164, 1949).

Once a swarm of locusts is on the wing, and as long as no winds in excess of flying speed are encountered, the initial orientation may be preserved for a long time – most probably by gregarious alignment of flying locusts on each other. This is suggested by observations on a large swarm which took off into a light wind, and for more than four hours was seen to maintain the same general orientation – in spite of a considerable change in the direction and strength of wind and consequent change in the direction of displacement.

The absence of any consistent orientation to wind would inevitably lead to displacement in a general down-wind direction – and most of the major seasonal displacements of swarms throughout the invasion area of *Schistocerca* are known to be down the prevailing seasonal winds, and to change with them, (WALOFF, Z. - Anti-Locust Mem. 1, London). Moreover, recent work by Dr. RAINEY on instances of long-range migrations, in an area where the seasonal trend appears to be against the prevailing seasonal wind, has shown that they were, in fact, down-wind displacements associated with occasional winds blowing in the direction opposite to that of the prevailing wind.

Mr. **Kennedy**: There is little doubt that mobile field observers actively seeking flying swarms are more likely to encounter swarms that are moving against the wind than in other directions, not only because, as Miss WALOFF says, progress is slow against the wind, but also because flight with the wind probably occurs more often away from the ground than close to it. So it can be agreed that a preponderance of up-wind cases among records collected from swarms encountered on different occasions, is not satisfactory evidence of a behavioural preference for up-wind orientation. In any case it has not been suggested that there is any "consistent orientation to wind"; there is no general preference for flying up-wind. The suggestion was rather that locusts show an up-wind preference only as the particular way in which a general tendency to make optical compensatory responses, is expressed in particular conditions, *viz.* close to the ground in winds which are not much slower than the locusts' ordinary "cruising" speed, nor faster than their maximum flying speed.

The evidence for that is not conclusive because it still rests largely on impressions. But it is derived in the first place from a series of continuous observations of immediate behaviour changes within one and the same swarm on one occasion, when the behaviour changes did seem to be consistently related to changes of wind speed and height of flight. There is no disagreement over the fact that low flying locusts may fly up-, across- or down-wind in winds below their flying speed. Nor is this inconsistent with the optomotor theory of wind orientation, which, however, goes further, in saying that the preference of low fliers for orienting into wind increases in strength up to their maximum flying speed. That this up-wind preference, which Miss WALOFF also observed at the time of the morning departure of swarms, arises only from "aerodynamic necessity", through mechanical responses to wind *prior* to take-off, is hard to credit, because locusts which have been flying on other courses nevertheless consistently turn into wind while still airborne, when they descend just prior to alighting.

That an orientation initially imposed by the wind may be maintained for a long time afterwards by other means, follows from all I have said, and this idea has been elaborated elsewhere, but it does not seem in any way to exclude active orientation to wind during flight, in suitable circumstances.

It is agreed, also, that the question is still open, as to how far seasonal migration trends which are against the prevailing wind result from flight actually against the wind, or from down-wind displacement on occasional winds blowing in the opposite direction. Dr. RAINEY's work is an important contribution to the subject. But whatever may be the final explanation, not only of those particular trends, but also of with-prevailing-wind trends and not least, of the periods where there is no clear geographical trend, the explanation is not likely to be reached by assuming, even as a working hypothesis, that we are dealing with inert particles when in fact we are dealing with living insects. Even should it turn out that all major trends result from down-wind displacement (which appears to be true of smaller, weaker insects) the key causal question here is: what, in the environment, and in the insect with its elaborate equipment of regulatory reactions, puts the insect temporarily into so "helpless" a situation at particular times.

SOME THOUGHTS ARISING FROM THE APPLICATION OF SOCIOLOGICAL INTERPRETATION TO ANT LIFE

by
D.WRAGGE MORLEY
London, England

Summary

We cannot compare the behaviour of ants and men. Yet ants are social animals — they live in communities in which the mother has experience of her young not just until, but after they become adult. The ants have a well developed learning ability, although the occurrence of "reasoning" is not proved. This may equally well be due to their different nervous and physiological structure as to the non-occurrence of reasoning in ants.

There are two major differences between the ant and man:

1. The ant exhibits no "directional" learning ability. No ant ever "says" to another ant "you come here and do this". It just does something and other workers, queens (females), or males, copy its actions, responding solely to their own inherent patterns of behaviour.

2. No ant can "write down" its experience. All ant-life is, to use the word philosophically, a perfect dialectic, unbroken by the isolation of experience involved in the writing down, formalisation, and analysis involved in the arts of man — literature, science, painting, music, etc.

This latter factor is the major behavioural difference between ants and man.

Yet the ants are social creatures and as LE BAN showed in "La Foule" we may learn much about the "basic" animal part of our behaviour from our studies of them, so long as we remember always to compare Man with the Ants, and *not* the Ants with Man.

BEOBACHTUNGEN UBER DEN REVIERBESITZ BEI DER ROTEN MAUERBIENE (Osmia rufa L.)

von

D. A. VLEUGEL
Den Haag, Niederlande

A. *Einleitung*

Im Mai 1943 beobachtete ich in einem Garten in Haag zum ersten Mal da Verhalten der Roten Mauerbiene in ihrem Fluggebiet. Es betraf nur ♀♀. Er im nächsten Jahr sah ich auch ♂♂. Das erste ♂ beobachtete ich am 14. Apr auf Löwenzahn (Taraxacum officinale Web.)

Schon am 19. April wurde es mir klar, dass die ♂♂ einen bestimmten We verfolgten, d.h. einen Revierflug zeigten. Am 23. April sah ich zum erste Mal einige ♂♂ aufeinanderstossen und markierte das erste ♂ auf die vo VON FRISCH (1931) angegebene Weise.

Von diesem Tage an beobachtete ich täglich die Osmien während mehrere Stunden und markierte weitere Tiere. Ende Mai waren die Bienen verschwun den.

Auch in den folgenden Jahren beobachtete ich öfters die Osmien bei ihre Revierflügen, obschon die Tiere nicht mehr markiert wurden. Bis einschliess lich 1951 haben wir das Verhalten der Bienen jeden Frühling beobachte können, sodass es angebracht erscheint, darüber jetzt etwas mitzuteilen.

B. *Das Erscheinen der ♂♂ und ♀♀ in den verschiedenen Jahren*

Wie bei den meisten Bienen, so gibt es auch bei der Roten Mauerbien Proterandrie. Die ♂♂ erscheinen durchschnittlich zwei, drei, vier oder soga mehr Wochen früher als die ♀♀. Das Wetter, vor allem die Temperatur, ha einen entscheidenden Einfluss. Die Frühjahrsbienen verlangen zum Fliege ohne Ausnahme reichlichen Sonnenschein, wie ich dies schon früher für di Graue Grabbiene (*Andrena vaga* Scop.) erwähnt habe (VLEUGEL 1947).

Wir verfügen nicht nur über die in Haag gesammelten phaenologischen Daten, sondern haben auch die des ersten Erscheinens der Roten Mauerbien von Pater P. BENNO (1946) verwerten können. Für Haag habe ich die folgen den ersten Daten gesammelt: 1944 14/4; 1945 10/4; 1947 10/4; 1948 18/4 und 1949 14/4. Für Zevenaar gibt Pater BENNO (l.c.): 1939 19/4; 1940 20/4; 1941 8/4; 1942 13/4; 1943 14/4; 1944 15/4 und 1945 24/3. Die Lage von Haag ist $52^{\circ}5'$N., $4^{\circ}18'$O. und die Lage von Zevenaar $51^{\circ}55'$N., $6^{\circ}5'$O.

Die ersten Roten Mauerbienen erscheinen meistens an einem der ersten Tage einer ausgesprochenen Gutwetterperiode mit reichlichem Sonnenschein. Das Datum 24/3/45 ist sehr früh und bildet wohl eine Ausnahme. In diesem Jahre war die Temperatur im letzten Märzdrittel über normal: Mittelwert 4.7°C, tägliches Maximum 5°C und tägliches Minimum 3.7°C. Auch im April blieb die Temperatur über normal, sodass der Flug der Bienen anhielt.

Auch im Jahre 1941 erschien diese Art früh. Obschon die Temperatur unter ormal war, war diesmal das frühe Erscheinen dem Umstande zuzuschreiben, ass es vom 5. bis 10. April eine Gutwetterperiode mit Ostwinden und sehr iel Sonnenschein gab. An sonnigen Stellen werden die Bienen dann offen-ichtlich veranlasst, trotz ungünstiger Temperatur im Schatten, zu Tage zu ommen.

In den Jahren 1939, 1940 und 1948 war diese Art spät. Für 1939 ist mir ie Ursache unbekannt. Im Jahre 1940 war die Temperatur aber merklich unter ormal, und im Jahre 1948 konnte ich die Ursache aufs Neue nicht nennen.

Das mittlere Datum des Erscheinens ist für Haag der 12. April (für 5 Jahre) nd für Zevenaar der 11. April (für 7 Jahre). Bei Strassburg erscheinen sie ach FRIESE (1922) Anfang April, während sie im Zimmer schon Mitte März usfliegen (l.c.). Der Zeitpunkt des Erscheinens im März, den SCHOLZ (1913) ennt, wird höchstens für südliche Breiten zutreffen. Nur in einem ausser-ewöhnlich warmen März kommen sie ausnahmsweise auch weiter nördlich o früh zum Vorschein. Die ersten Daten, an welchen die ♀♀ in Haag gese-en wurden, sind folgende: 1944 10/5; 1945 23/5; 1946 21/5; 1947 11/5 und 948 29/4. In Zevenaar sah Pater BENNO sie an den folgenden Daten zum rsten Mal: 1940 25/4; 1941 28/5; 1942 2/6; 1943 18/4; 1944 27/5 und 945 19/4.

Mai 1941 war sehr kalt, so dass die ♀♀ erst am 28. Mai auftraten. Auch lai 1942 war kalt, vor allem, weil desöfteren starke Winde wehten. Die rsten ♀♀ wurden dadurch nicht vor dem 2. Juni gesehen. Ebenso waren die rsten zwei Drittel des Monats Mai 1944 zu kalt, so dass die ♀♀ erst am 7. Mai anfingen zu fliegen.

Im Jahre 1943 erschienen dagegen die ♀♀ schon früh (18/4). Dieser Monat ar durchschnittlich zu warm. Andere Jahre in denen die Bienen früh anfingen u fliegen waren 1940, 1945 und 1948. Die betreffenden Monate waren alle urchschnittlich zu warm. Im Mai 1944, einem normalen Monat, wurden die rsten ♀♀ am 10. Mai gesehen. Dieses Datum stellt ungefähr den Mittelwert ar.

Als Mittelwert fanden wir für Haag den 14. Mai (für 5 Jahre). In Zevenaar urde als durchschnittliches erstes Flugdatum der 10. Mai festgestellt (für Jahre).

Die ♀♀ erscheinen also durchschnittlich einen Monat später als die ♂♂. In aag ist wegen der Meeresnähe die Temperatur im Mai etwas niedriger als in evenaar.

. *Das letzte Auftreten der ♂♂*

Im Jahre 1944 sah ich mit Gewissheit die letzten ♂♂ am 10. Mai. Es ist iemlich schwierig, die ♂♂ in dieser Zeit von den ♀♀ zu unterscheiden, weil ie ♂♂ ihr Verhalten ändern. Sie zeigen während dieser Zeit keine schnellen evierflüge mehr, sondern fliegen ruhig auf den Blumen umher. Die ♀♀ sam-eln nicht so schnell und so ähneln sich beide Geschlechter sehr. Aller-ings ist der Clypeus des ♂ hellgrau gefärbt und der des ♀ ist dunkel. Je-

doch sieht man dieses nicht so rasch wie bei den schnellen Revierflüger der ♂♂.

Im Jahre 1947 beobachtete ich aufs Neue lange genug, um das letzte Au treten der ♂♂ sicher feststellenzukönnen. Am 21. Mai sah ich noch mehrer ♂♂. In zwei Jahren war also das mittlere Datum des letzten Auftretens d ♂♂ der 15. Mai. Die ♂♂ fliegen also durchschnittlich vom 12. April bis zu 15. Mai, also fast 5 Wochen. FRIESE sagt: „Überall im März-April." De Zeitpunkt des letzten Auftretens muss also für die geographische Breite vo Holland etwas hinausgeschoben werden.

D. *Der Revierflug*

Man kann nicht sagen, dass *Osmia rufa* ein Revier hat wie manche Voge arten (cf. HOWARD 1921). Ein Fitislaubsänger (Phylloscopus trochilu Bechst.) z.B. hat, wie ich mehrere Jahre genau beobachtete, ein festes Re vier. Den ganzen Tag kann man ihn dort finden. Er schläft auch da, und da Revier wird nur selten kurz verlassen. Nicht so bei der Roten Mauerbiene.

Erstens befinden sich die Schlafplätze ausserhalb des Reviers. Währen Schlechtwetterperioden bleiben die Bienen auch nicht im Revier, sondern a ihrem Ruheplatz ausserhalb des Reviers.

Die ersten Mauerbienen fliegen bei sonnigem Wetter nur kurze Zeit un her. Sie sonnen sich sehr viel. Nach einigen Tagen beginnen sie mit ihre Revierflug, vor allem dann, wenn die Temperatur, verursacht durch reichl chen Sonnenschein, rasch steigt. Gegen Ende der Flugperiode, also Anfan bis Mitte Mai verringert sich der Revierinstinkt allmählich und man begegne immer mehr Bienen, die sich ruhig auf den Blumen befinden oder sich au Blättern, Steinen oder an Wänden sonnen.

An sonnigen Apriltagen mit normaler Temperatur erscheinen die Tierche ungefähr um 10 Uhr. Kurze Zeit saugen sie Honig, dann fängt der Revierflu an. Dieser wird immer schneller und öfter ausgeführt, je wärmer es wird Wird es zu warm, so werden die Flüge eingestellt. An schlechten Tage (Regen, Kälte, u.s.w.) erscheinen die Tierchen natürlich auch nicht. Gege Ende der Flugperiode, an kalten, aber sonnigen Tagen, ist es auch möglich dass sie kurze Zeit fliegen. Ausserdem auch an wärmeren Tagen mit bewölk tem Himmel. Unter denselben Umständen würden sie jedoch zu Anfang de Flugperiode nicht fliegen.

Unter optimalen Bedingungen werden die Revierflüge zirka 15 bis 20 Ma in der Stunde durchgeführt. Die Bienen fliegen allem Anscheine nach nich sehr lange. Die Flüge kosten wahrscheinlich viel Energie und werden zu intensiv ausgeführt, um allzu lange dauern zu können.

Die Revierflüge am Morgen werden meistens von anderen Tieren ausge führt wie die am Mittag. Häufig erscheinen die Bienen auch nicht mehrer Tage hintereinander; auch nicht bei gutem Wetter. Sie ruhen sehr viel, wi dieses auch von den Hummeln bekannt ist (cf. PLATH 1934).

An heissen Tagen wird um die Mittagszeit nicht geflogen. Die Biener verlegen dann ihren Revierflug auf die kühleren Stunden am Vormittag. Si

erscheinen erst wieder, wenn die grösste Wärme vorüber ist und fliegen bisweilen bis zum Sonnenuntergang.

Man sieht die Tierchen nur sehr wenig Honig saugen. Es geschieht vor allem dann, wenn die ersten ♂♂ am Vormittag erscheinen. Auch wenn die Flugzeit fast vorüber ist, nehmen sie wieder Nektar zu sich, also vor allem an normalen Flugtagen nach vier Uhr oder auch früher, wenn es Bienen betrifft, die ihre Ruheplätze früher wieder aufsuchen.

Die Bienen sonnen sich viel, auch wieder meistens am Anfang und Ende des Flugtages. Auch zwischen den Revierflügen setzen sich die Tierchen öfters zum Sonnen nieder. Je wärmer die Tage werden, je kürzer sieht man die Bienen sich sonnen.

Wenn die ♂♂ ihren Revierflug ausführen, wobei sie immer dieselben Blumengruppen, Blumen, Sträucher u.s.w. besuchen, gibt es oft Begegnungen zwischen zwei *Osmia*männchen. Sie verfolgen einander dann mehr oder weniger, stossen oft sehr stark aufeinander und versuchen einander zu verjagen. Auch auf sitzende ♂♂ wird gestossen. Wird ein ♀ erkannt, so versucht das ♂ zu kopulieren. Sehr viele Versuche habe ich gesehen, niemals aber gelang eine Kopulation. Ich sah dies wohl von *Osmia aena* L., ganz im Anfang der Flugperiode der ♀♀. Auch auf andere, vor allem sich bewegende Insekten wird gestossen. So sah ich *Osmia rufa* ♂♂ auf *Halictus calceatus* Scop., *Apis mellifera* L., *Anthophora acervorum* L. und auch bisweilen auf Fliegen stossen. Mehrfach sah ich, dass z.B. Honigbienen zeitweise verjagt wurden.

Bisweilen tummeln die *Osmia rufa* ♂♂ sogar auf den Blumen herum. Unter Umständen werden während der Revierflüge auch Stellen besucht wo Nesthöhlen sein können und die ♂♂ fliegen suchend an Wänden u. dgl. umher.

Den Revierflug dehnen sie auf eine Distanz von schätzungsweise 10 bis 20 Meter aus. Es war schwierig, dieses festzustellen, weil der Flug sich über benachbarte Gärten erstreckte.

Obschon ich mehrere *Osmia rufa* ♂♂ markiert habe, sah ich die Tierchen nicht lange. Die drei ♂♂ die ich am längsten beobachtet habe, sind die Folgenden:

a. *Osmia* grün. Ich markierte dieses ♂ am 23. April um 13 Uhr 10. Am 24. April sah ich es wieder, als es sich auf Blättern des Gemüsekohls sonnte. Nachher sah ich es am selben Tag den Revierflug ausführen. Am 29. April sah ich es erneut. Am 30. April flog es schon zum letzten Mal.

b. *Osmia* rot. Am 23. April um 14 Uhr 50 wurde dieses Tierchen markiert. Am folgenden Tag sah ich es wieder von 13 Uhr 10 bis 13 Uhr 20 den Revierflug ausführen. Am 27. April flog es zwischen 12 Uhr 15 und 13 Uhr 20 wieder den Revierflug. Am 28. April sah ich es zwischen 13 Uhr und 13 Uhr 30 wiederholt dasselbe tun.

c. *Osmia* rot. Dieses ♂ wurde am 30. April um 12 Uhr markiert. Ich sah es am selben Tag zwischen 12 Uhr und 14 Uhr 30 mehrmals zurück und auch wieder erneut um 16 Uhr 25. Am 2. Mai sah ich es wieder. Nach einer Schlechtwetterperiode war es am 9. Mai wieder da, also am 10. Tage.

Es scheint also, dass die Tierchen nicht länger fliegen als ungefähr zehn Tage. In Übereinstimmung damit sieht man auch Anfang Mai noch frisch

geschlüpfte ♂♂. Wie bereits erwähnt, kann man die ♂♂ nach Mitte Mai meistens nicht mehr beobachten.

Summary

The ♂♂ appear in April, sometimes March, before the ♀♀. The average date of the first appearance of the former from 1944 until 1949 at The Hague was April 12th. The average date for the first appearance of the ♀♀ on the other hand was May 14th from 1944 until 1948. The average date of the last occurrence of the ♂♂ for the years 1944 and 1947 was May 18th.

The ♂♂ make a territorial flight from one group of flowers or bushes to another. A fixed route, more or less circular is followed for 10 - 20 metres, perhaps more. When a ♂ encounters another ♂, it darts at it and a tiff arises. The ♂♂ not only dart at bees of their own species, but also at *Anthophora acervorum* L., *Halictus calceatus* Scop., *Apis mellifera* L. and sometimes flies.

When a ♀ is recognized, the ♂ that darts at it, tries to copulate it. On sunny days the ♂♂ often perform their territorial flights for some hours. When the weather is colder, there are far less territorial flights taking place. On hot days, however, the bees are not to be seen, except in the cooler hours.

Other activities of the ♂♂ are : sun-bathing, circling to search for ♀♀ on apparent nesting-places and honey-sucking. The latter activity takes little time, for it is chiefly to be seen after the bees have left their resting-places and before they return to them again.

On sunny days the territorial flight is made at a rate of 15 - 20 times an hour. The bees fly several hours on those days. When the weather is less fine,the bees soon disappear again.

One cannot observe marked individuals for a long time. The males that have been seen for the longest time were *Osmia* "green" (April 23th till April 30th); *Osmia* "red" (April 23th till April 28th) and *Osmia* "white" (April 30th till May 9th). In the last case a period of bad weather interfered.

Newly emerged bees are to be seen until the beginning of May. For that reason they do not appear to have a long life as adults. After the middle of May the ♂♂ have nearly all disappeared.

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DISCUSSION

Mr. **Noirot**: Est-ce que le mâle attaque un autre mâle ou une Halicte p.ex. si cet insecte se trouve non pas sur le trajet parcouru par le mâle, mais à l'intérieur de la surface ainsi délimité?

Mr. **Vleugel**: Les mâles ou une Halicte p.ex. sont attaqués aussi à l'intérieur de la surface ainsi délimité.

Mr. **Boerema**: The bees apparently stay away from their "territories" for intervals of several days. What are they doing these other days? Do they perhaps use different "territories" on different days?

Mr. **Vleugel**: This is a difficult problem to solve, but there are indications. It has been proved in other species that females very often rest in their nests, also on sunny days. So it is probable that the males, too, are often in their resting-places. But I do not know whether they have only one "territory" or more and how often they stay on neutral grounds. As a matter of fact there are places e.g. trunks of trees, walls and the like, where several males regularly fly and sun in peace.

It is clear that we shall have to mark a sufficient number of males in several "territories" at the same time before we know whether they frequent one or more "territories" in the course of time. This cannot be done by one observer. Besides, one has to observe all day and this was impossible to me.

Mr. **Baerends**: Is it allowed to use the word "territory" here. "Territory" in vertebrates has been defined as a topographical area defended by an owner. In the case of *Osmia* the topographical element is a fixed route but, as Mr. VLEUGEL has pointed out the routes often overlap. It is unwise to enlarge the definition of a word too much because we want definitions to distinguish different phenomena and too wide definitions will therefore hamper deeper research.

Mr. **Vleugel**: Yes, there is a more or less defined route, but within the area enclosed the males are attacking too. However, it is hardly possible to follow the *Osmia* males precisely as they also zigzag in their "territories", flying from one side to another.

Several definitions of territory have been given so far, one cannot quite decide from the behaviour of the species whether its behaviour can be brought under one of the existing definitions, whether the definition should be enlarged or whether there should be given a new name.

Mr. **Grassé**: J'ai eu l'occasion d'étudier sur une grande échelle le comportement des femelles d'*Osmia rufa*. Des femelles ayant leurs nids côte à côte (jusqu'à 80 nids) ne se disputent pas et ont des „espaces vitaux" sensiblement les mêmes, visitant toutes ou presque les mêmes lieux. La constance de l'espace visité, exploité est à peu près constante pour une femelle d'*Osmia rufa*.

Mr. **Deleurance**: M. VLEUGEL peut-il certifier que le comportement d'attaque observé chez les mâles d'*O. rufa* ne correspond pas au comportement copulateur normal déclenché par un insecte étranger; ce qui expliquerait les

observations du Professeur GRASSÉ sur l'absence de combat entre femelles tolérantes sur un même territoire?

Chez *Polistes* les mâles foncent souvent sur un objet mobile et paraissent l'attaquer. En réalité il s'agit vraisemblablement du déclenchement copulateur et non d'une attaque. M. VLEUGEL pense-t-il pouvoir éliminer cette interprétation?

Mr. **Vleugel**: Même chez les oiseaux on observe un phénomène semblable, difficile à expliquer. Par exemple, quand un pouillot fitis (Phylloscopus trochilus Bechst.) mâle ou femelle entre dans le territoire d'un pouillot fitis mâle alors qu'il n'y a pas encore de femelle fixée là, souvent on ne peut pas distinguer avec précision si le mâle résident veut attaquer ou copuler. C'est la même chose chez *Osmia rufa*.

Une femelle de pouillot est laissé en repos après des essais infructueux de copulation et peut rester sur le territoire tandis que les mâles envahisseurs sont attaqués sans cesse et généralement ils quittent le territoire.

C'est de nouveau la même chose chez *Osmia rufa*. Une femelle d'*Osmia rufa* est laissé en repos après des essais infructueux de copulation et peut rester sur le territoire tandis que les mâles qui restent sur le territoire, sont attaqués sans cesse.

Les femelles d *Osmia rufa* sont toujours sociables et n'attaquent jamais sur les fleurs.

SECTION VI

ECOLOGY AND BIOLOGY

THE NUMBER OF INSTARS AMONG THE THYSANURA AS INFLUENCED BY ENVIRONMENT

by

HARVEY L.SWEETMAN
Amherst, Mass., U.S.A.

The Thysanura are known to molt throughout life, replacing broken and njured appendages in the process (SWEETMAN, 1934). Most insects are apable of molting and repairing injured parts during the immature stages nly. The molting of five firebrats, *Thermobia domestica* Pack., was observed 1 an earlier series throughout their lives (SWEETMAN & WHITTEMORE, 937). One died in the eighteenth instar, three died in the thirty-eighth to orty-second instars, and one escaped during the thirty-eighth instar. At that ime it was estimated from the length of life of individuals greater than those bserved that some might live sufficiently long to reach the sixtieth or greater umber of instars.

Such a figure was considerably greater than ever recorded for any insect. ne of the firebrats above died in the forty-second instar (SWEETMAN & HITTEMORE, 1937).

IDE (1935) had given evidence to show that a species of mayfly had beween forty and forty-five molts during its development. Further observations n the molting of three species of thysanurans, the four-lined silverfish, *tenolepisma quadriseriata* Pack., the firebrat, *Thermobia domestica* Pack., nd the silverfish, *Lepisma saccharina* L. have corroborated these earlier ndings and predictions. The food and general methods of culture have been escribed (SWEETMAN, 1938).

The four-lined silverfish was reared at 27° C. and relative humidity usually ear 77 per cent (SWEETMAN, 1941; SWEETMAN & KULASH, 1944). The umber and length of instars are given in Table 1. Number 3 was reared in 7, No. 4 in 62 and No. 7 in 50 per cent relative humidity. Each individual as isolated throughout the observations. One insect was accidentally killed 1 the thirty-ninth instar. The average length of instars increased from 2 ays in the first to 12 in the third instar, then an increase of about half a ay per instar from the third through the fifteenth. Thereafter the average er instar was about 22.5 days. The length of the first instar was influenced y the incubation temperature. Those incubated at 32° (Nos. 1, 5, 6, 8 and 4) with one exception molted during the first day, while those incubated at 2° (Nos. 11, 12 and 15) did not molt until the third day after hatching.

Five individuals exceeded 50 instars, during their lives and two lived to e sixty-sixth instar (Table 1). These five individuals lived from 1055 to 417 days. The two individuals that died in the sixty-sixth instar lived nearly ur years. Larger individuals have been observed in stock cultures. Since ey increase in length during most of their life, it suggests that some speci-

mens may have 70 or more instars and live for more than four years. Several individuals died following failure to molt successfully. Usually the head was not successfully withdrawn. Starvation may have been involved in the death of some of these individuals since they were unable to feed. This handicap was sometimes overcome in the following molt.

The nymphs became clothed with scales in the fourth instar (Table 1). The first pair of ventral abdominal styli appeared in the fifth instar, the second pair of styli usually in the tenth instar. The third pair of ventral styli appeared from the twelfth to fifteenth instar, with one exception which was in the twenty-first instar. One female, No. 14, developed the third stylus on one side in the thirteenth and on the other side in the fourteenth instar.

The firebrats were reared in separate cages until mature. They were maintained near optimum conditions (ADAMS, 1933a; SWEETMAN, 1938) with the exception of one series. The number and length of instars at 32° and 37° C. are given in Table 2. The average length of instars at 37° increased rapidly from about 1 to 10 days during the first 14 instars. While considerable variation in length of instars occurred thereafter, the average was about 11 days (SWEETMAN & WHITTEMORE, 1937). When reared at 32°, a temperature below the optimum, the instar length gradually increased from about 2 to 20 days during the first 20 instars and averaged about 2 to 22 days thereafter. Thus lowering the temperature 5° about doubled the length of the instars.

Five firebrats exceeded 40 instars and two exceeded 50 instars during their lives (Table 2). The greatest number of instars was 58 at 37° and 57 at 32° C. The individuals with 40 instars or more at 37° attained ages of 416 to 551 days. A firebrat at this temperature in another series reached an age of 675 days, the equivalent of about 11 instars more than above, suggesting that long-living individuals may attain 70 or more instars and an age of two years or more during a life time. The greatest length of life was at 32°, this female attained an age of 1009 days or 2.8 years.

Following maturation of the females of *Thermobia,* males were placed with five (Nos. 10, 11, 13, 14, 17) of the seven females in the series at 37°, three of which reproduced (Table 2). The two unpaired females (Nos. 4 and 6) lived longer, 390 and 416 days, than the mated females. The heaviest producing female laid 144 eggs in 11 separate lots and lived to an age of 297 days, the longest of the females that reproduced. However, heavily reproducing firebrats in other series lived considerably longer than any of the above females.

The nymphs became clothed with scales in the fourth instar. The appearance of ventral abdominal styli has been discussed earlier (SWEETMAN & WHITTEMORE, 1937). The first pair of styli appear externally in the fifth instar, not fourth as stated by ADAMS (1933b). The males usually develop only two pairs of styli, while the females typically have three pairs.

The silverfish were maintained near optimal physical conditions (SWEETMAN, 1939). Each insect was reared separately. The number and length of instars are given in Table 3. Two individuals were killed in the nineteenth

and thirtieth instars and two escaped in the twenty-first and twenty-third instars. The average number of days per instar increased rapidly from 2.3 to over 20 days during the first 10 instars, and extended to about 40 days by the fifteenth instar. The remaining instars ranged from about 40 to 50 days with an average length of about 43 days. The instar in which death occurred was frequently much prolonged, suggesting a physiological inability to molt with age.

Eight individuals exceeded 30 instars and one lived to the forty-first instar (Table 3). The latter individual lived 1354 days, or 3.7 years. Certain specimens molted much less frequently than others.

The nymphs became clothed with scales in the fourth instar (Table 3). The first pair of ventral abdominal styli appeared in the fifth instar. The second pair usually appeared in the eighth or ninth instar but occasionally in the tenth or eleventh instar.

Conclusion

The reproductive age among the Lepismatidae is reached at about the tenth instar. Reproduction and molting continue throughout life. Half or more of the increase in length and weight occurred after the tenth instar. The maximum number of instars recorded was 58 at 37° and 56 at 32° C. for the firebrat and 66 for the four-lined silverfish. It is estimated from longer living individuals that 70 or more instars may be reached by both species. These figures are greater than for any other species of insect, although a mayfly was stated by IDE (1935) to undergo 40 to 45 molts during its immature development, which is greater than for the immature life of the thysanurans. The maximum number of instars for the silverfish was 41, although the length of life was double that of the firebrat. The Lepismatidae attain ages of two to four years or more.

The nymphs become clothed with scales in the fourth instar and acquire externally the first pair of abdominal styli in the fifth instar. The second pair of styli appear usually in the seventh to tenth instar and the third pair in the tenth to fifteenth instar. The silverfish and male firebrats typically have only two pairs of styli. The molting and mating habits of the Lepismatidae suggest that they are more closely related to the Arachnida than to the Apterygote insects.

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DISCUSSION

Mr. **Wolcott**: At what stage does growth cease? What survival value has moulting?

Mr. **Sweetman**: Apparently growth continues throughout or nearly throughout life. I do not know any survival value of moulting. Moulting is a very critical period and often death occurs when moulting is incomplete.

Mr. **Tuxen**: Is the first instar of the Lepismatids morphologically different from the following instars, e.g. in the mouthparts?

Mr. **Sweetman**: The first instar is different in shape, has no scales and no ventral styli; the morphology of the mouthparts I have not studied.

Mr. **Hinton**: The need to mate in each instar is probable, because the sperm is lost at the moult.

Mr. **Handschin**: I should like to emphasize the parallel of development amongst Collembola, which show the same features in the number of moults + periods of life.

Table 1. The number and length of instars of the four-lined silverfish, *Ctenolepisma quadriseriata* Pack., when reared at 27° C and 50 to 97 per cent relative humidity

s denotes scales, *d* death, *k* killed, *m* molting difficulty, and ' first, '' second and * third pair of styli.

Instar	No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average days per instar
	Sex															
1	1	2	2	2	1	1	2	1	2	2	3	3	2	2	3	2.0
2	7	7	6	7	8	8	7	8	6	7	6	6	7	8	6	6.9
3	12	12	11	14	11	14	12	14	12	13	12	11	13	13	13	12.4
4	16s	12s	13s	13s	16s	14s	10s	16s	12s	15s	13s	8s	13s	15s	15s	13.4
5	12'	13'	9'	15'	13'	12'	16'	15'	11'	14'	13'	8'	12'	11'	13'	12.6
6	14	13	12	15	15	14	16	18	15	15	14	12	13	13	15	14.4
7	14	15	12	16	13	14	11	14	13	14	16	14	15	15	19	14.6
8	16	14	15	18	14	17	13	17	15	14	14	11	19	17	17	15.4
9	16	17	14	18	16	16	14	17	16	17	15	18	16	18	15	16.2
10	15''	16	12	18''	15''	18	15''	19''	17''	16	20	14''	17''	20''	16''	16.5
11	17	16''	17	20	18	22	15	17	16	17''	16	16		19	18	17.4
12	17	21	15''	23	18*	21''	16	20	19	19	17''	18	(37)	19	20	18.7
13	23*	25	14	20	19	17	7*	21	20*	19	16	17*	14	16*	19*	17.9
14	18	21	20	21*	19	16	10	19*	21	18	31*	19	19	18*	23	19.2
15	20	22*	20	20	16	18*	14	20	19	20*	25	21	17*	17	21	19.3
16	27	22	15	19	19	22	19	19	22	24	25	20	18	21	23	21.0
17	11	20	15	18	26	20	16	18	19	22	23	27	22	20	21	19.9
18	22	21	19	21	21	20	18	19	19	22	22	30	26	21	28	21.9
19	26	19	16	20	22	20	22	18	20	20	17	22	20	16	25	20.2
20	28	17	13	24	21	23	17	27	23	19	26	22	25	20	26	22.1
21	28	20	14*	26	22	20	20	20	23	20	17	21	20	23	23	21.1
22	23	20	16	24	27	23	20	25	21	19	19	21	19	28	32	22.5
23	17	20	19	34	25	25	19	19	21	23	19	26	19	19	27	22.1
24	21	20	15	30	18	24	25	18	17	19	24	29	15	16	33	21.6
25		22	16	27		21	24	22	32	27	21	20	23	24	28d	23.6
26	(49)		16	24	(42)	25	21	21	26	20	25	22	22	14d		22.2
27	36	(50)	19	21	23	21	17	20	25	32	20	21	25			23.3
28	36	24	18	21	20	26	18	22	21	22	22	24	20			22.6
29	26	19	19	21	23	24	22	23	24	22	21	21	23			22.2
30	20	19	16	38	22		30	20	21	27	22	22	42d			23.4
31	31	21	21	26		(52)	23	21		24	22	18				23.0
32	27	22	21	32	(46)	33	18	22	(38)	23	26	28				25.2
33	18	22	18	18	18	27	18	23	20	24	27	24				21.4
34	10	23	19	9	30	18	20	29	24	21	21	14d				20.4
35	11	26	16	20	21	19	22	17	22	18	28					20.0
36	43	21	20	32	19	26	19	24	20	18	40					25.6
37		24	18		29	24	20		24	17	23					22.4
38	(73)	29	20	(62)	21	16	20	(52)	13	10	27					19.5
39	28	23	20	32		14	18	30	25	23k	19d					23.8
40	27	23	23	30			16	19d	3d							23.8
41	23		24	23	(73)	(48)	8d									23.3
42	23	(44)	21	20	27	19										23.4
43	20	33	21	21	18	18										21.8
44	20	24	22	25	21	22										22.3
45	23	22		18	26	20										21.8
46	26	22		22	17	20										21.4
47		22	(71)	31	19	20										23.0
48	(41)	26	19	48	21	21										27.0
49	20	22	19	45	21	23										25.0
50	25	29	22	37	19	20dm										25.3
51	25	29	21	23	18											23.2
52	33		23	27	19											25.5
53	19	(40)	21	33	17											22.5
54	19	22	21	28d	12dm											20.7
55	22	29	20													23.7
56	21	26	18													21.7
57	20	22	18													20.0
58	20	23	20													21.0
59	21	23	22													22.0
60	21	21	17													19.7
61	26	20	20													22.0
62	22	25	19													22.0
63	21	20	4d													20.5
64	18	24														21.0
65	20	28														24.0
66	12dm	24dm														
Total	1417	1393	1097	1282	1055	996	688	784	737	736	787	629	553	443	499	

ÜBER DIE METEOROLOGISCHEN VERHÄLTNISSE BEI FALTER-WANDERUNGEN [1)]

von

H.SEILKOPF

Hamburg, Deutschland

1) Beobachtung und Problemstellung

Von den in den mitteleuropäischen Raum einfliegenden Wanderfaltern fällt neben dem einzelfliegenden Admiral, *Pyrameis atalanta* L., der Distelfalter *P.cardui* L., wohl am meisten auf, wenn sich auch seine Zugschwärme nördlich der Alpen in der Regel auflösen (nach G.WARNECKE).

Im bayerischen Alpengebiet konnte in der ersten Juni-hälfte 1950 ein Massenauftreten von *P.cardui* festgestellt werden. Beobachtungsgebiet war der Westteil des Garmischer Talkessels nördlich des Zugspitzmassives und Höhen der Zugspitzgruppe selbst . Am 9. und 10.6. kamen auf einer Alm südlich von Grainau und am Kramer einzelne Exemplare zur Beobachtung. Am 12. wurden auf einer Höhenwanderung im Kreuzeck-Gebiet zwischen 1600 und 1700 m überall Distelfalter gesichtet; häufig hatte man mehrere gleichzeitig im Gesichtsfeld. Auf einer 2. Höhenwanderung im gleichen Gebiet am 15. wurden dort oben wieder zahlreiche Falter beobachtet, bemerkenswerterweise viele mit beschädigten Flügeln. Am 19. Juni zeigten sich beim Abstieg vom Riffelries auf der Nordseite der Zugspitze oberhalb der Baumgrenze wiederholt Falter.

Dieses Massenvorkommen von *P.cardui* ist zufällig beobachtet worden. Ohne weitere Meldungen kann nicht beurteilt werden, ob es sich um einen Einflug grösseren Ausmasses oder um eine örtliche Erscheinung gehandelt hat. Es stehen aber meteorologische Beobachtungen zur Verfügung, die einen Beitrag zur Frage des Zusammenhanges des Einfluges dieses subtropischen Falters mit den Witterungsverhältnissen ermöglichen. Dahinter steht das Problem etwaiger Beziehungen von Falterwanderungen zu meteorologischen Faktoren, für das einige weitere faunistische und meteorologische Beobachtungen herangezogen werden können.

2) *Der Witterungsverlauf und Wetterlage*

Die Witterung im Beobachtungsgebiet lässt sich durch die Beobachtungen des Zugspitz-Observatoriums (2962 m) und der Wetterwarte Garmisch-Partenkirchen (703 m) verfolgen.

An beiden Stationen waren die Monate Mai und Juni 1950 wärmer, trockener und reicher an Sonnenschein als normal, wie die folgende Zahlentafel zeigt (G = Garmisch-Partenkirchen, Z = Zugspitze):

1) Der Aufsatz wurde von G.WARNECKE, Hamburg, nach Erläuterung einiger mit den Wanderungen zusammenhängenden Probleme vorgetragen.

Instar		No. 1	32° C. 20	21	22	Average days per instar
		Sex				
1		1	2	2	2	2.0
2			4	5	5	4.6
3			10	9	9	9.6
4		(13)s	10s	10s	10s	9.6
5		7	7	7	7	7.0
6		6	7	2d	2d	7.7
7		8	8			8.0
8		7	13			11.7
9		4	2d			11.5
10		7				12.0
11		7				11.0
12		8				10.5
13		9				10.5
14		7				15.0
15		11				17.0
16		7				15.0
17		10				18.0
18		11				15.0
19		9				
20		13				
21		16				23.0
22		9				23.0
23		9				27.0
24		12				23.0
25		10				23.0
26		7				20.0
27		12				12.0
28		5				9.0
29		15				23.0
30		15				21.0
31		11				22.0
32		16				13.0
33		11				21.0
34		9				26.0
35		9				16.0
36		10				27.0
37		14				24.0
38		10				24.0
39		8				22.0
40		8				22.0
41		16				27.0
42		10				25.0
43		10				20.0
44		9				35.0
45		10				11.0
46		10				13.0
47		9				28.0
48		11				23.0
49		10				23.0
50		11				20.0
51		10				22.0
52		11				17.0
53		11				23.0
54		12				21.0
55		12				19.0
56		12				21.0
57		13				
58		3d				
Total days		551	63	35	35	

Table 2. The number and length of instars of the firebrat, *Thermobia domestica* Pack., when reared at 37° C and 32° C. and 84 per cent relative humidity

s denotes scales, *e* eggs, *d* death, and *m* molting difficulty

Instar		37° C.																	Average days per instar	32° C.					Average days per instar
		No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		18	19	20	21	22	
		Sex																							
1		1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1.0	2	2	2	2	2	2.0
2			4	5	3	3	4	3	3	3	3	4	4	3	3	3	3	3	3.4	4	4	4	5	5	4.6
3			6	6	5	5	4	6	5	5	4	6	4	5	5	5	4	4	5.0	10	10	10	9	9	9.6
4		(13)s	6s	8s	5s	6s	7s	6s	6s	6s	5s	5s	6s	6s	7s	7s	5s	4s	6.0	9s	9s	10s	10s	10s	9.6
5		7	6	7	6	7	8	7	7	7		8	8	7	6	6			7.0	7	7	7	7	7	7.0
6		6	11	7	8	8	6	5	8	7	(13)	5	8	8	7	6	(13)	(13)	7.1	8	8	7	2d	2d	7.7
7		8	8	7	6	7	9	7	8	6	8	5	9	7	8	6	8	8	7.4	8	8	8			8.0
8		7	8	7	10	10	7	10	9	9	6	8	7	8	9	10	10	8	8.4	13	9	13			11.7
9		4	9	11	8	8	11	6	8	8	8	6	9	8	9	11	13	7	8.5	12	11	2d			11.5
10		7	8	7	13	8	11	8	8	10	9	9	9	10	8	8	15	9	9.2	12	12				12.0
11		7	9	9	8	9	10	9	9	9	13	14	8	10	9	8	17	7	9.7	11	11				11.0
12		8	8	7	17	10	7	10	9	9	19	9	9	10	9	8	11	9	9.9	7	14				10.5
13		9	7	8	9	8	6	9	9	7	11e	11	10	12	11	8	9	7	8.9	10	11				10.5
14		7	10	8	7	11	14	7	11		12	8	10	11	13	9	10	13	10.1	15	4d				15.0
15		11	10	9	9	8	9	16	11	(20)	14e	9	12	13	14	15	7	15	11.3	17					17.0
16		7	8	11	18		13	8	13	9	13e	9	11	14	14e	15	10	11	11.5	15					15.0
17		10	10	8	10	(21)	7	10	12	10	12e	17	11	11	13	10	17	11	11.2	18					18.0
18		11	11	10	11	10	16	11	14	12	9	11	11	14	16	9	16	10	12.0	15					15.0
19		9	10	11	18	11	8	10	12	10	15e	12	12	11e	14	11	7	10d	11.3						
20		13	9	16	11	10	13	9	15	11	12e	11	14	10	10	11	12		11.7	(32)					
21		16	12	9	7	11	10	14	10	13	13e	9	12	15	12	15	7		11.6	23					23.0
22		9	8	9	10	11	12	9	10	10	12	8	7	11	15e	7	9		9.8	23					23.0
23		9		16	10	11	12	8	16	10	10	11	4	13e	6	11	5d		10.5	27					27.0
24		12	(20)	12	14	11	10	17	14	10	12e	13	14	20d	7d	12d			12.6	23					23.0
25		10	11	11	12	12	13		11		9	7	13						10.9	23					23.0
26		7	11	12	11	12		(24)	6	(20)	12	16	12						11.0	20					20.0
27		12	12	11		11	(26)	10	11	10	11	12	17d						11.1	12					12.0
28		5	17	13	(28)	12		10	14	10	10e	12							11.4	9					9.0
29		15		13	12		(28)	12	10	14	12e	12							12.5	23					23.0
30		15	(22)	10	11	(23)	12	11	14	9	9de	8d							11.7	21					21.0
31		11	7	9	12	11		13		12									10.7	22					22.0
32		16	10	10	13	11	(24)	11	(21)	8d									11.8	13					13.0
33		11	10	13	12	11	11	13	8d										11.6	21					21.0
34		9	11	11	13	12	11												11.2	26					26.0
35		9	11	10	10	13	10	(21)											10.5	16					16.0
36		10	10	12	12	15	12	25d											11.8	27					27.0
37		14	11	11	9	13	10												11.3	24					24.0
38		10	13	15	9	16	17												13.3	24					24.0
39		8	14	13	13	28d	1d												12.0	22					22.0
40		8	9	8	11														9.0	22					22.0
41		16	12	11	4d														13.0	27					27.0
42		10	8	12															10.0	25					25.0
43		10	9	13															10.7	20					20.0
44		9	8	1d															8.5	35					35.0
45		10	8																9.0	11					11.0
46		10	9																9.5	13					13.0
47		9	6																7.5	28					28.0
48		11	8																8.5	23					23.0
49		10	26d																10.0	23					23.0
50		11																	11.0	20					20.0
51		10																	10.0	22					22.0
52		11																	11.0	17					17.0
53		11																	11.0	23					23.0
54		12																	12.0	21					21.0
55		12																	12.0	19					19.0
56		12																	12.0	21					21.0
57		13																	13.0	15d					
58		3dm																							
Total days		551	472	427	416	405	390	356	324	286	297	275	252	238	226	212	209	137		1009	120	63	35	35	

instar	No. 1	19	20	21.	22	23	Average days per instar
	Sex						
1	2	2	2	3	3	2	2.3
2	5	5	6	6	5	(16)	5.7
3	9	9	10	9	11		9.8
4	10s	10s	11s	15s	13s	13s	11.6
5	12	11	13	13	12	13	12.4
6	11	13	15	14	20	16	13.5
7	10	15	18	19	17	17	14.1
8	17	18	17	19	16	14	15.4
9	19	15	18	23	17	26	18.1
10	23	39	35	16	25	39	22.4
11	30	37	26	35	31	36	25.1
12	33	26	22	23	29	50	24.3
13	25	43	29	26	44	86	30.3
14	33	45	42	6	51	94	35.7
15	41	99	41	22	58	68	39.3
16	47	46	63	19	52	83	40.2
17	66	65	34	45	81	153d	40.3
18	48	83	89	46	98d		50.2
19	37	168d	133d	12k			43.2
20	43						46.2
21	44						56.2
22	35						45.1
23	30						49.8
24	46						34.5
25	55						45.6
26							44.8
27	(71)						45.4
28	50						46.2
29	45						40.5
30	49						48.6
31	42						38.9
32	38						37.1
33	60						41.5
34	34						37.8
35	23						30.0
36	46						40.7
37	37						30.5
38	39						41.0
39	36						31.0
40	34						34.0
41	19d						
tal days	1354	749	634	371+	583	726	

Table 3. The number and length of instars of the silverfish, *Lepisma saccharina* L., when reared at 27° C and 84 per cent relative humidity.
s denotes scales, *d* death, *m* molting difficulty, *k* killed, *esc* escaped, and ' first and '' second pair of styli.

Instar	No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Average days per instar
	Sex																							
1	2	2	2	2	2	2	3	3	2	3	2	2	3	3	2	2	2	2	2	2	3	3	2	2.3
2	5	6	6	7	5	6	6	5	6		8	5	6	6	4	5	5	7	5	6	6	5		5.7
3	9	9	9	10	12	10	9	9	10	(14)	10	10	11	11	10	8	12	8	9	10	9	11	(16)	9.8
4	10s	14s	11s	10s	10s	11s	13s	14s	11s	11s	12s	11s	10s	13s	10s	10s	14s	10s	10s	11s	15s	13s	13s	11.6
5	12'	10'	12'	14'	14	11'	9	12'	10'	15'	12	12'	14	15	13	12'	14	13'	11	13	13	12	13	12.4
6	11	12	12	16	11	14	6	14	12	9	17	16	14	17	13	12	16	11	13	15	14	20	16	13.5
7	10	13	13	17	9	15	14	15	15	13	19	13	11	8	17	14	7	16	15	18	19	17	17	14.1
8	17	17	16''	16	11	16''	12	16''	15	14	15	14''	10	16	15	14''	18	19	18	17	19	16	14	15.4
9	19	18''	17	21	19	18	9	21	20''	16''	7	16	8	21	16	18	24	19''	15	18	23	17	26	18.1
10	23''	15	19	20	16	20	10	18	19	21	30	18	15	36	8	21	31	21	39	35	16	25	39	22.4
11	30	20	21	22''	19	28	13	28	23	25	33	20	5	29	12	23	34	27	37	26	35	31	36	25.1
12	33	25	25	24	13	31	5	31	21	28	29	28	8	12	19	33	16	27	26	22	23	29	50	24.3
13	25	24	30	32	19	37	13	24	34	35	39'	24	8	22	23	36	14	30	43	29	26	44	86	30.3
14	33	25	23	35	50	37	13	33	28	32	49	36	8	12	34	58	40	36	45	42	6	51	94	35.7
15	41	30	38	21	30	40	12	31	48	32	40	35	9	24	43	47	59	35	99	41	22	58	68	39.3
16	47	31	28	38	47	40	27	42	41	35	39	27	14	38	46	34	54	33	46	63	19	52	83	40.2
17	66	30	38	57	47	63	27	42	36	45	40	34	14	44	47	31	43	37	65	34	45	81	153d	40.3
18	48	44	49	49	45	49	34	33	30	59	61	46	28	55	64	50	51	51	83	89	46	98d		50.2
19	37	53	46	52	23	44	49	35	35	31	54	38	10	56	65	45	57	47	168d	133d	12k			43.2
20	43	40	49	51	25	46	52	47	38	25	63	38	24	75	67	37	62	49						46.2
21	44	45	51	53	72	49	58	42	35	34	54	49	46	181	49	37	38esc	36d						56.2
22	35	51	39	42	61	39	64	44	36	35	46	45	49	118d	112d	7d								45.1
23	30	48	27	49	68	51	69	36	54	42	78	45	20esc											49.8
24	46	37	30	44	63	45	75	44	26	22	47	35												34.5
25	55	19	34	39	52	39	72	40	48	18	73	58												45.6
26		32	35	39	72	43	92	38	32	25	40	115d												44.8
27	(71)	45	38	39	50	42	74	49	38	33	157d													45.4
28	50	49	52	40	45	41	70	36	40	39														46.2
29	45	37	26	39	49	42	55	37	36	39														40.5
30	49	51	42	36	36	51	60	38	73	23k														48.6
31	42	41	33	24	59	35	38	21d	113d															38.9
32	38	43	25	23	45	35	51																	37.1
33	60	35	44	32	35	43	131d																	41.5
34	34	32	31	46	48	36																		37.8
35	23	28	31	38	25d	62d																		30.0
36	46	39	37	2dm																				40.7
37	37	24	35d																					30.5
38	39	43																						41.0
39	36	26																						31.0
40	34	18d																						34.0
41	19d																							
Total days	1354	1179	1074	1099	1207	1196	1245	898	985	773+	1074	790	345+	812	689	554	610+	534	749	634	371+	583	726	

	Temperatur				Niederschlag		Sonnenscheindauer	
50	Mittel		Abweichung		% d.Normalen		% d.Normalen	
	G	Z	G	Z	G	Z	G	Z
i	13.6°	– 0.8°	+ 2.6°	+ 1.8°	54	79	141	138
ni	17.5°	+ 2.6°	+ 3.6°	+ 2.5°	44	37	146	163

Im Einzelnen tritt im Mai eine Folge sehr warmer, überwiegend heiterer d trockener Tage vom 20. bis 25. hervor, an denen die Höchsttemperaturen den Tälern 25° erreichten oder überschritten; in Garmisch stiegen sie bis f 32°, am Zugspitzobservatorium bis auf 9° am 21. an. Nach einem unter gleitung von Gewittern erfolgenden Kaltlufteinbruch in der Nacht vom ./26. Mai, der auf der Zugspitze die Tiefsttemperaturen am 27. bis auf °, am 29. bis auf –7° senkte, folgte eine zweite Periode sehr warmer, nniger und vorherrschend trockener Witterung vom 3. bis zum 13. Juni (nur erbrochen von der 1. „Sommermonsun"-Welle am 9. und 10.), in der die mperaturen in Garmisch 29° am 8., auf der Zugspitze 10° am 11. erreichten. diese Zeit sehr warmer Witterung fiel das Massenauftreten von *P. cardui.* witter am 13. nachmittags leiteten dann einen Abschnitt zwar noch warr, aber sommerlich wechselhafter Witterung mit häufigen Gewittern und gen ein. Am 15., als in föhnig-klarer Luft die Sichtweite mehr als 100 km rug, zeigten sich viele Falter mit Flügelschäden, die auf das Gewitter am nachmittags oder auf die starken Schauer am 14. nachmittags zurückzuren sein dürften (Einsatz der 2. Sommermonsunwelle).

Die sommerliche Witterung in der 1. Junihälfte stand zunächst unter dem nfluss eines festländischen Hochdruckgebietes mit sich von Tag zu Tag värmender Festlandluft in den unteren Luftschichten. Vom 4. Juni an flosı auf der Vorderseite von Tiefdruckstörungen im Biskayaraum vom Mitteler her über Frankreich subtropische Luftmassen zu, die am 7. selbst im itschen Küstengebiet Höchsttemperaturen bis zu 30° brachten. Nach vorrgehendem Zustrom von gealterten polaren Luftmassen am 9. und 10. zten sich die subtropischen Luftmassen erneut durch.

Ein verhältnismässig einfaches Bild der Vorgänge erhält man, wenn man die Temraturverhältnisse in der unteren Hälfte der Troposphäre durch „relative Topograen" (thickness patterns) darstellt: Man benutzt als „Thermometer" die über zahlhen aerologischen Stationen stehende Luftsäule, in welcher Druck, Temperatur, ichte, und Wind bis zu grossen Höhen hinauf regelmässig gemessen werden. Die erschiedliche Länge der vertikalen Luftsäule, die durch ein unteres und ein höhe- Luftdruckniveau begrenzt wird, ist ein Mass für die Mitteltemperatur dieser Luftile; bei höheren Temperaturen, welche die Luftsäule vertikal ausdehnen, liegt die re Begrenzung höher als bei tieferen Temperaturen. Als obere Begrenzung nimmt ı allgemein die Höhe, in der der Luftdruck 500 Millibar beträgt (1 Millibar – mb – enähert 3/4 mm Quecksilbersäule), als untere die Höhe von 1000 mb. Die Tempera-verteilung in der unteren und mittleren Troposphäre wird dann dargestellt durch ı Abstand der 500 mb-Fläche von der die Bodenluftdruckverteilung bezeichenden 0 mb-Fläche. Diese Karten der Schichtdicke 500/1000 mb werden als „relative pographien" 500/1000 mb bezeichnet. Bei einer Mitteltemperatur der Luftsäule von)° beträgt deren Länge, also die Schichtdicke 5530 m, bei +10° 5730 m.

Bildet man für die Tage vom 4. bis 13. Juni 1950 Mittelwerte der relative Topographie 500/1000 mb, so hebt sich als charakteristisch eine „Warmlu zunge" heraus, die vom westlichen Mittelmeer sich nordwärts über Westeuro und dem westlichen Mitteleuropa aufwölbt (hohe Werte der Schicht 500/10 mb, grosser als 5620 m) (Karte 1). Im Norden und Osten ist es dagegen kal ebenso ist es im Raume vor der Biskayasee im Bereich tiefen Luftdrucks r lativ kalt. Die Tageskarten zeigen, dass die subtropische Warmluftzunge a 9. und 10. vorübergehend zurückgedrängt (und in die Höhe gehoben) wird, da aber sich erneut durchsetzt.

Räumlich ausgedehnte und langsam wandernde oder quasi-stationäre Warmluftzu gen bringen über Land in der wärmeren Jahreshälfte warme, heitere und überwieger trockene Witterung. Wolkensysteme und Niederschläge treten erst an ihren Rände auf oder dort, wo die warme und meist auch feuchte Luft auf Kaltluft aufgleitet od wo Kaltluft in die davorliegende Warmluft einbricht und zu Umlagerungs- und Hebung vorgängen führt. Die grossen Warmluftzungen entsprechen dem Modell des Warmsek tors I. Ordnung der grossen atmosphärischen Zirkulation, das früher beschrieben wo den ist. Solche Warmluftzungen kann man als „Klimazungen" betrachten, welche i der wärmeren Jahreszeit die klimatischen Verhältnisse ihres Ursprungsgebietes we nordwärts ausbreiten. Wie die Beobachtungen zeigen, traf dies auch im Juni 1950 zu.

Diese Feststellung bedeutet aber, dass in diesen Warmluftzungen sub tropische Falter auch in den unteren Luftschichten ein klimatisches Milie antreffen, das weitgehend dem ihres Ursprungsgebietes entspricht. Hinz kommt, dass die Warmluftzungen in den grossen subtropischen Warmluft-Reservoiren wurzeln und sich aus ihnen heraus entwickeln; sie werden in de Höhe grösstenteils, in den unteren Luftschichten mindestens zu einem Tei durch die Advektion subtropischer Warmluft gebildet und erhalten. So könne Falter im Einzelfalle mit subtropischen Warmluftmassen in nördlichen Richtungen versetzt werden. Zu beachten ist, dass eine derartige Verschiebun von Luftmassen etwas ganz anderes ist als der bodennahe Wind. So kann sic in subtropischen Warmluftmassen über dem Festland ein Hochdruckgebie aufbauen, an dessen Südabhang in Süddeutschland in den unteren Luftschichten östliche Winde wehen.

3. *Wanderzüge und Wetterlage*

Im Juni 1950 ist Wander*zug* nicht festgestellt worden. Betrachtet man die aus den letzten Jahren bekannt gewordenen Fälle von echten Wanderzügen, bei denen das Datum angegeben ist, so ergibt sich folgendes Bild:

Am 6. Juni 1948 ist in der Nordschweiz starker Wanderzug von *P.cardui* beobac tet worden (G.WARNECKE in litt.). Die Karte der rel.Topographie vom 6. nachmittag (Karte 2) zeigt ebenfalls eine sich vom westlichen Mittelmeer aufwölbende Warmluftzunge, die sich am 7. noch weiter nordwärts ausdehnt. Am 10. und 11. wird sie stark eingeengt, regeneriert sich aber wieder durch erneuten Zustrom subtropische Luft und bleibt bis zum 16. Juni liegen.

Aus dem Jahre 1946 wird von drei Wanderzügen von *P.cardui* im westlichen Alpengebiet berichtet, die eine vom Süden nach Norden vom 30. Mai an bei Genf und dann zwischen dem W.und 7. Juni von Zürich nach Basel, ein weiterer am 4. und 5. Juli in den Basses Alpes von Südwest nach Nordost und schliesslich ein dritter am 5. Juli bei Zürich von Westen nach Osten, der mit dem zweiten in Zusammenhang stehen könnt

Am 30. Mai weist die troposphärische Temperaturverteilung (Karte 3) zwar wieder eine Warmluftzunge auf, sie lag aber schon weit östlich und wurde

om 1. Juni an durch Kaltluft weiter ostwärts zurückgedrängt; erst am 5. und . Juni zog dann eine neue rasch wandernde Warmluftzunge durch. Entspricht lieser Ablauf nicht den bisher erörterten Fällen, so ist bei dem weiteren Beispiel vom 5. Juli 1946 die Übereinstimmung wieder gut (Karte 4). Wieder rstreckte sich eine Warmluftzunge vom westlichen Mittelmeer nordwärts, in liesem Falle bis Nordskandinavien. Sie hatte sich am 2. über Westeuropa ufgewölbt und wurde am 6./7. Juli durch vordringende Kaltluft nach Osteuropa zurückgedrängt. Bemerkenswert erscheint die Richtungsabweichung der Vanderzüge (Nordost und Ost) und das Vorrücken der Kaltluft mit den entsprechenden Wettervorgängen (Wetterverslechterung am 6.).

Besonders interessant ist in dieser Hinsicht der von E.PALMÉN am 25. Juni 946 von 12 bis 18h an der finnischen Küste beobachtete gemischte Wanderzug von P.*cardui* und *Plusia gamma*, der von Nordwest nach Südost führte. Auch an diesem Tage wurde die Wetterlage im osteuropäischen Raume von einer Warmluftzunge beherrscht (Karte 5). Sie erstreckte sich vom Schwarzen Meer und Südrussland nordwestwärts nach Südfinnland und Mittelskandinavien, während in Nordnorwegen, in Lappland, Kola und über dem Eismeer Kaltluft bereitlag. In den unteren Luftschichten verlief die Massengrenze zwischen der auf der Rückseite eines nordwestsibirischen Tiefdruckgebietes einströmenden polaren Kaltluft und der im Süden anstehenden Warmluft am 25.6. früh vom Onegasee und Ladogasee westwärts quer durch das südliche Finnland, dort übergehend in eine Warmfront eines Tiefdruckgebietes über dem Nordmeer. Bis zum Abend war diese Warmfront bis zur Bottenwiek vorgerückt, während die Kaltluft über Nordrussland sich südwärts ausgebreitet hatte, sodass die Massengrenze vom Ladogasee nunmehr nordwestwärts zur Bottenwiek eichte.

Auch in diesem Falle können wir eine bemerkenswerte Zugrichtung (NW-SO) zur Zeit einer Verlagerung der troposphärischen Luftmassen im Fluggebiet feststellen.

Eine weitere Zugbeobachtung liegt im Schrifttum vom Kohlweissling, *Pieris brassicae* L., vor. G.WARNECKE beobachtete in Hamburg-Altona am 22. und 23. Juli 1947 sehr starken, von Norden nach Süden gehenden Zug, nachdem schon am 19. und 20. sich Flüge bemerkbar gemacht hatten. Vom 18. bis 21. lag das Gebiet unter dem Einfluss von Kaltluftmassen, die am Ostabhang eines skandinavischen Hochdruckgebietes zu uns gelangt waren. Am 22. setzte dann der Zustrom subtropischer Warmluftmassen aus Südwesten ein, der wieder zum Aufbau einer Warmluftzunge und zu sommerlicher warmer Witterung (bis zum 30.7.) führte (Karte 6).

Ähnlich wie in dem vorigen Fall zielte die Zugrichtung am *östlichen* Abhang der Warmluftzunge südlich. Die Dynamik der hochreichenden atmosphärischen Druck- und Strömungssysteme ergibt, dass die Windströmung in der Höhe der troposphärischen Temperaturverteilung entspricht und am Ostabhang von Warmluftzungen nordwestliche Höhenwinde wehen, am westlichen Abhang südwestliche.

Dies kann als Hinweis gewertet werden, dass die *Zugrichtung* der Wanderflüge mit der Dynamik der atmosphärischen Systeme zusammenhängen *kann*. Ausserdem besteht die *Möglichkeit*, dass von den Gleit- und Umlagerungsvorgängen an den Grenzen warmer und kalter Luftmassen ausgehend meteorotrope Reize auch im Schmetterlingsorganismus gesetzt werden. An die Narbenschmerzen und ähnl. Erscheinungen beim Menschen bei Annäherung von Warmluft in der Höhe sei in diesem Zusammenhang erinnert. Es *kann* durchaus sein, dass über die klimatischen Milieureize (Warmluft, Schönwetter) hinaus scheinbare Fernwirkungen auftreten, etwa durch elektromagnetische, von den bezeichneten atmosphärischen Vorgängen und den begleitenden Kondensationserscheinungen stammende Strahlungen.

Zusammenfassung

Es werden die atmosphärischen Verhältnisse bei einem Massenvorkommen von *Pyrameis cardui* im Juni 1950 und bei Wanderflügen verschiedener Falter in den Jahren 1946 bis 1948 untersucht.

Für die behandelten Frühsommerfälle sind troposphärische, sich nordwärts ausdehnende Warmluftzungen charakteristisch, in denen zugleich manche Eigenschaften subtropischen Klimas nordwärts ausgebreitet werden. In einigen Fällen sind abweichende Zugrichtungen, besonders bei hochsommerlichen Rückflügen Besonderheiten der troposphärischen Temperaturverteilung zugeordnet, was ein Hinweis auf das Richtungsproblem sein kann. Es wird die Möglichkeit erörtert, dass ausser den unmittelbaren Klima-Milieu-Reizen auch andere meteorotrope Reize wirken können.

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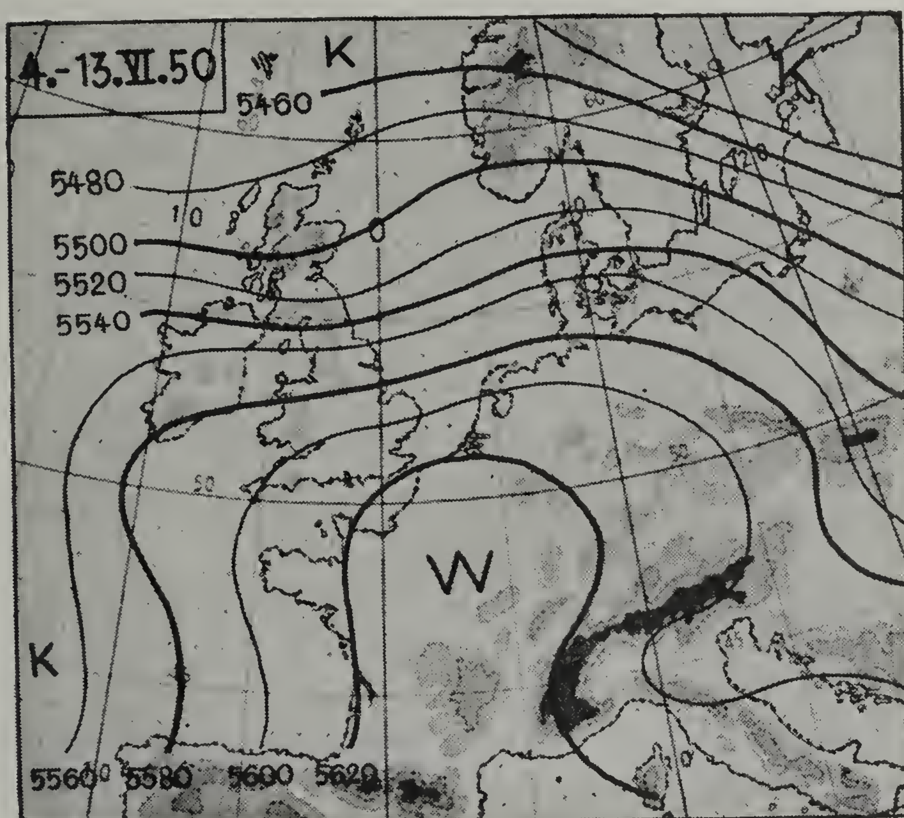
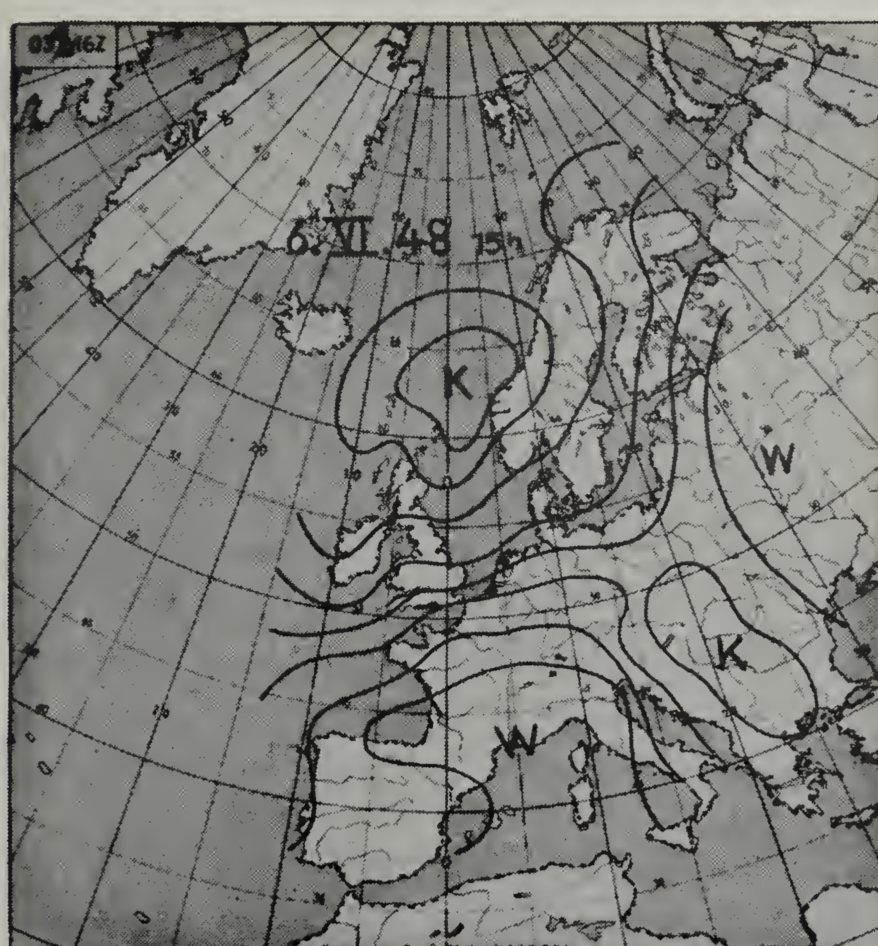
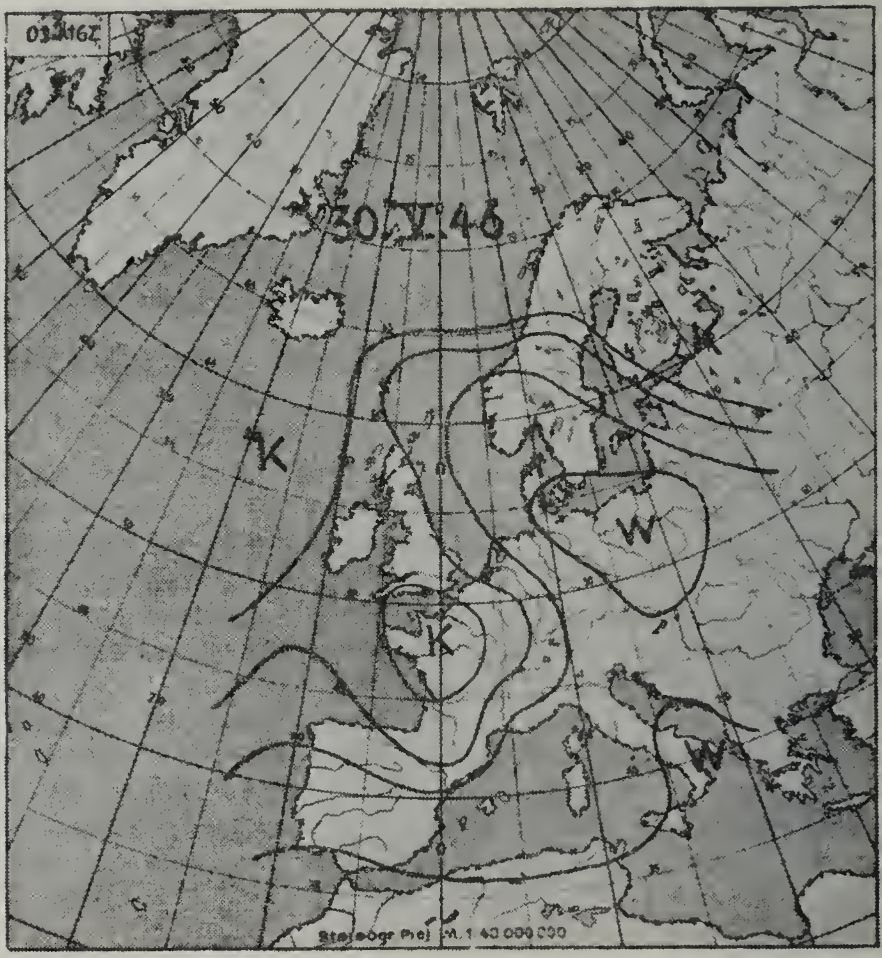
DISCUSSION

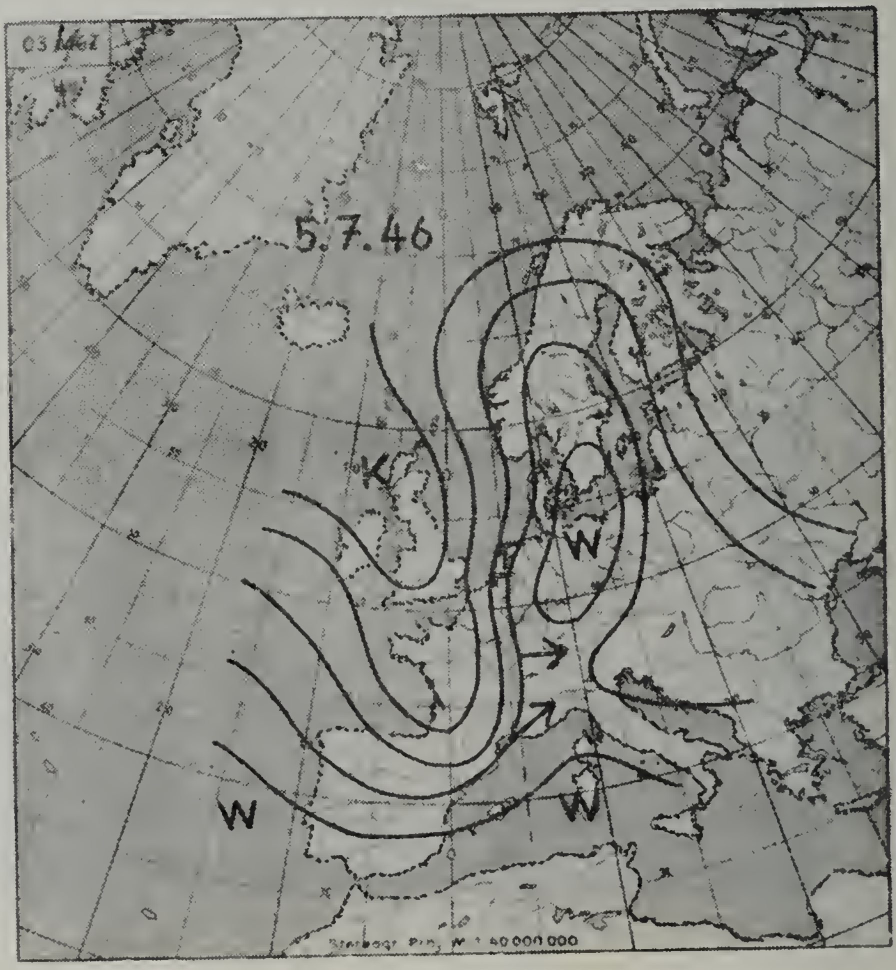
Mr. **Pasternak**: Klimakarten können dieses Problem wohl noch nicht klären. Klimatische Verhältnisse sind wohl conditiones sine quabus non, aber doch nicht conditiones per quas diese Wanderungen ausgelöst werden. Hier sind doch wohl physiologische Vorgänge ausschlaggebend.





Karten 1 (oben) und 2 (unten).
Für die Erklärung s. Text.





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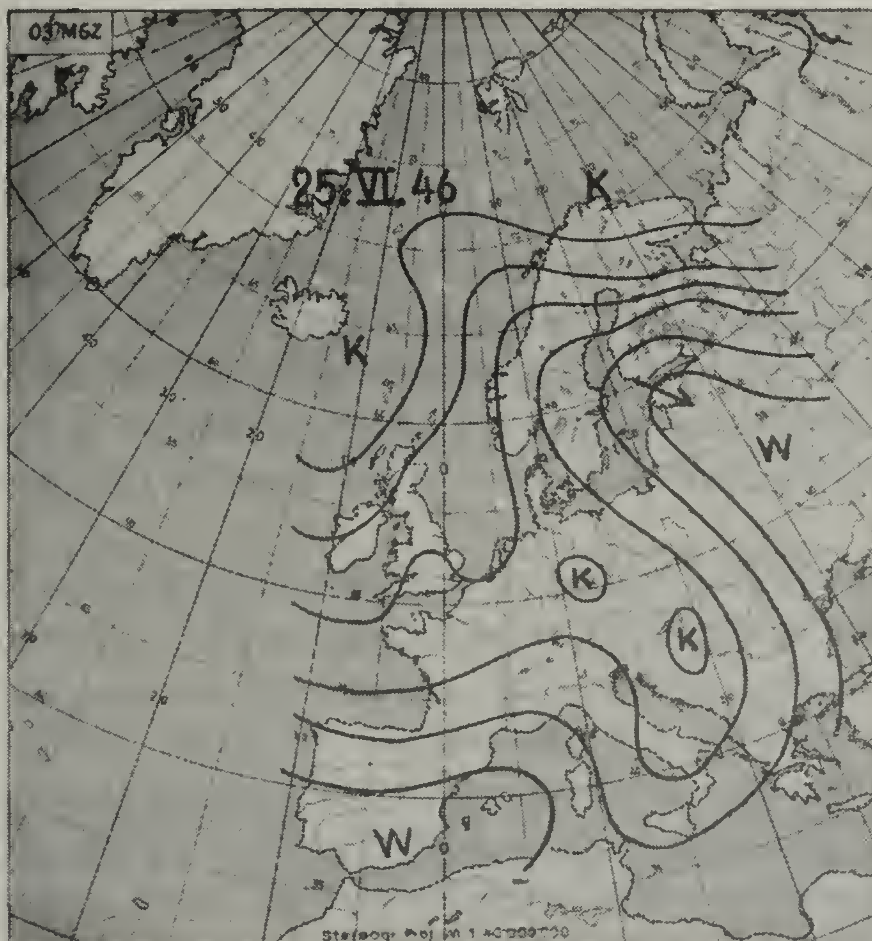

Karten 5 (oben) und 6 (unten).
Für die Erklärung s. Text.

MICROARTHROPODS FROM SOME DANISH SOILS

by

N.HAARLØV
Copenhagen, Denmark

From spring 1942 to summer 1943 I investigated the fauna of microarthropods in some Danish soils. The samples were taken at a depth of 5–10 cm having a surface area of 1/1000 m^2, i.e. a volume of 50–100 cm^3. In winter samples were taken once or twice a month, in summer twice or three times a month. The animals were driven out of the samples by means of the Tullgren technique.

The habitats investigated are: a) *Common* (228 individuals per sample). b) *North-side of ant-hillocks* on the common (426 individuals per sample). c) *South-side of the hillocks* (275 individuals per sample). d) *Forest* (338 individuals per sample). e) *Lake-shore* in the forest (86 individuals per sample). Besides these habitats four others have occasionally been investigated.

From each habitat the animals collected were determined to species and counted, and fauna lists were established.

I – Did the fauna lists indicate any relationship between the populations from the habitats mentioned?

To elucidate this I have used a method invented by the Danish botanist: TH.SØRENSEN *). The fundamental principles of this method are as follows: the statistical unit is the species, and it deals with occurrence or non-occurrence of the species between two populations. I.e. it is purely qualitative. The degree of similarity between two populations is expressed by a *Quotient of Similarity* $(QS) = \frac{2c}{a+b} \times 100$. a expresses the number of species within one population, b the number of species within the other and c the number of species common to both populations. Graphically the degree of similarity between the populations from my habitats can be seen from fig. 1.

II – After having seen how the populations are related it might be useful to study – quantitatively as well as qualitatively – their content of the various species.

To elucidate this problem I have drawn up diagrams for each of the populations, giving the percentage of dominancy along the abscissae and the percentage of frequency (constancy) along the ordinate. Only species with coordinating frequencies above 40% and dominancies above 2% have been considered. All the animals are drawn with the same magnification. – I.e. that in this way each diagram will give a picture of species content, number of individuals and relative sizes of the species from each of the populations.

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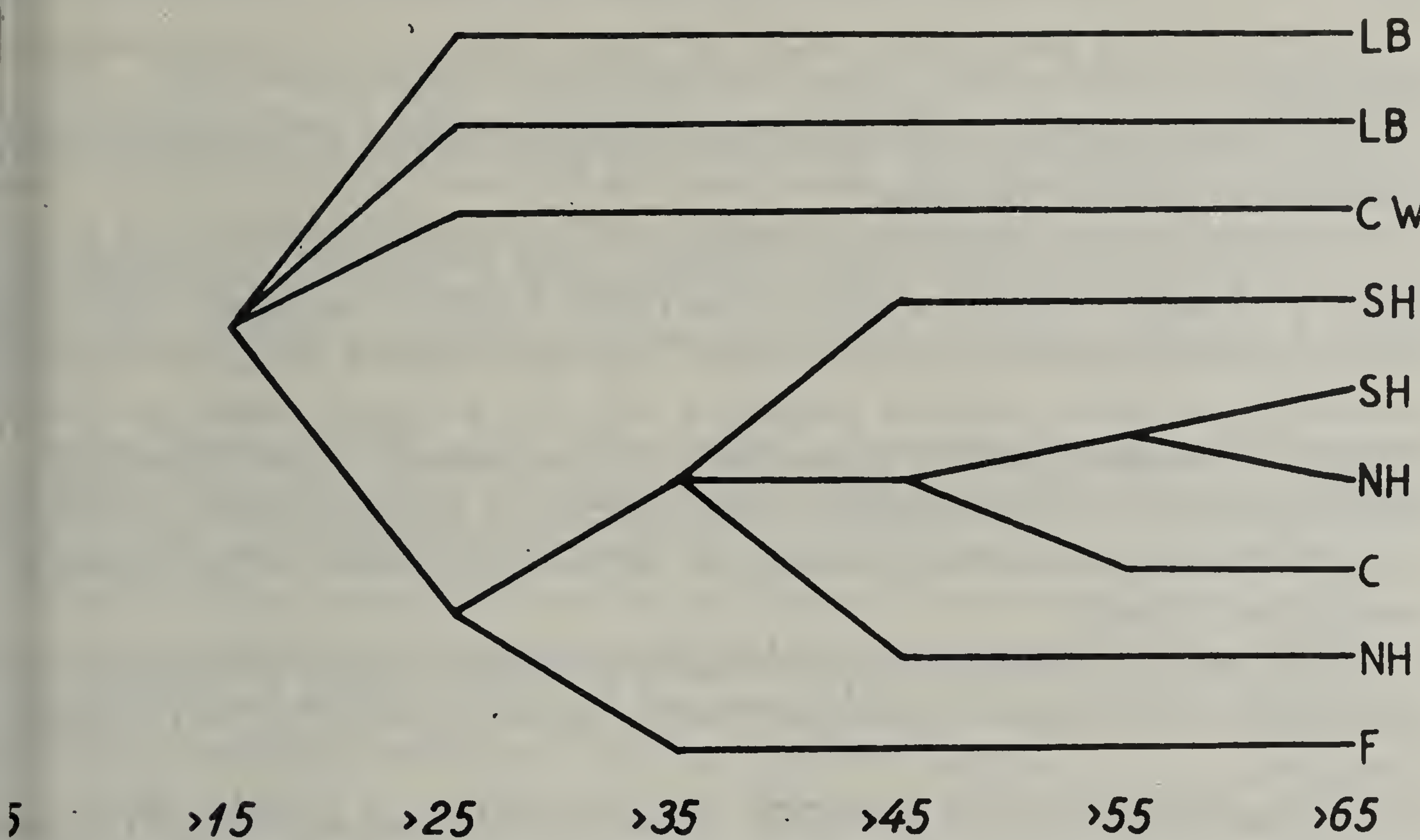
*) SØRENSEN, TH. – A method of establishing Groups of Equal Amplitude in Plant Sociology based on Similarity of Species Content.
Dan. Biol. Skr. V 4 1–34, 1948.



. 1 – Populations from the nine habitats investigated, arranged after Th.SØREN-
N's method. QS: along the horizontal line; habitats: LB, lake bank (upper from Ma-
ı sø, lower from Dyrehaven). CW, wet commons (Dyrehaven). SH. south-side of
-hillocks (upper Knurrevang, lower Dyrehaven). NH, north side of ant-hillocks,
per Dyrehaven, lower Knurrevang). C, commons (Dyrehaven). F, forest floor (Dyre-
en).

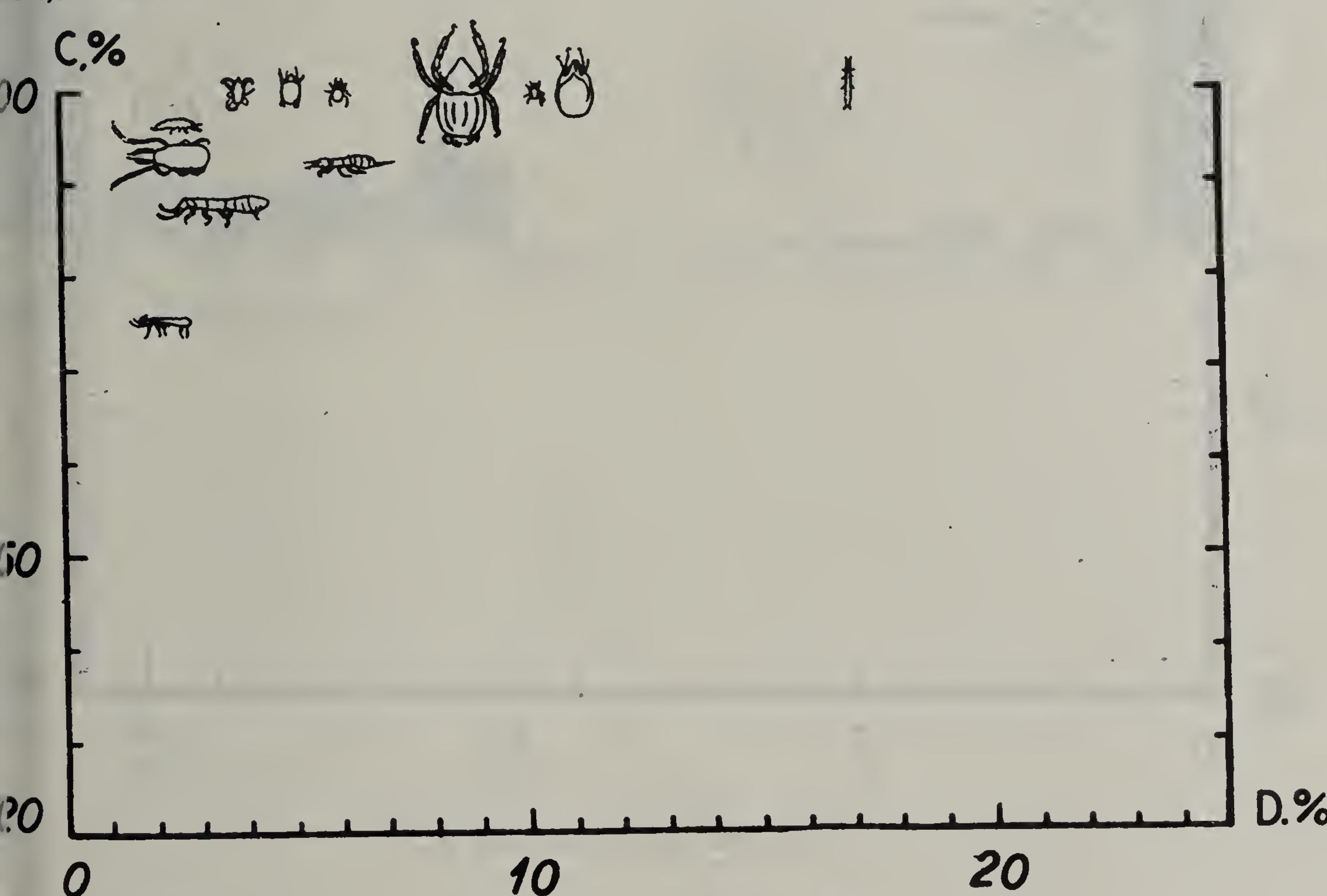


Fig. 2a. Constancy-dominancy diagram of forest population.
Rhodacarus sp, C:94, D:2,7; *Eupodes viridis*, C:100, D:3,6; *Friesea mirabilis*, C:96, D:2,5; *Tullbergia krausbaueri*, C:100, D:17; *Folsomia quadrioculata*, C:88, D:3,4; *Isotoma minor*, C:76, D:2,3; *Isotoma notabilis*, C:92, D:6,1; *Brachychthonius* spp, C:100, D:10,2; *Suctobelba trigona*, C:100, D:6,3; *Chamobates schützi*, C:100, D:5,0; *Notaspis coleoptratus*, C:100, D:11; *Platynothrus peltifer*, C:100, D:8,6.

In fig. 2a the forest population has been treated in the above-mention manner.

III – The next step will be to show which of these animals from the di grams are the most important.

To solve this problem fauna pictures have been made according to tl lines previously adopted with the constancy along the ordinate. But contra to the previous ones the species have now been placed along the absciss according to their: length x breadth x with the average number per sampl Length x breadth will be proportional to the surface of an individual, a approximately to the *metabolism* of it. Multiplied with the average number p sample the surface and metabolism of all the individuals of the species p sample are found.

Besides the metabolism these values give you an idea of the size of t *pore-spaces* that must be available for the animals in the soil of the differe habitats.

Treated in this way it is clearly shown how the animals from f.inst.fore (fig. 2b) change their mutual positions compared with the first diagram.

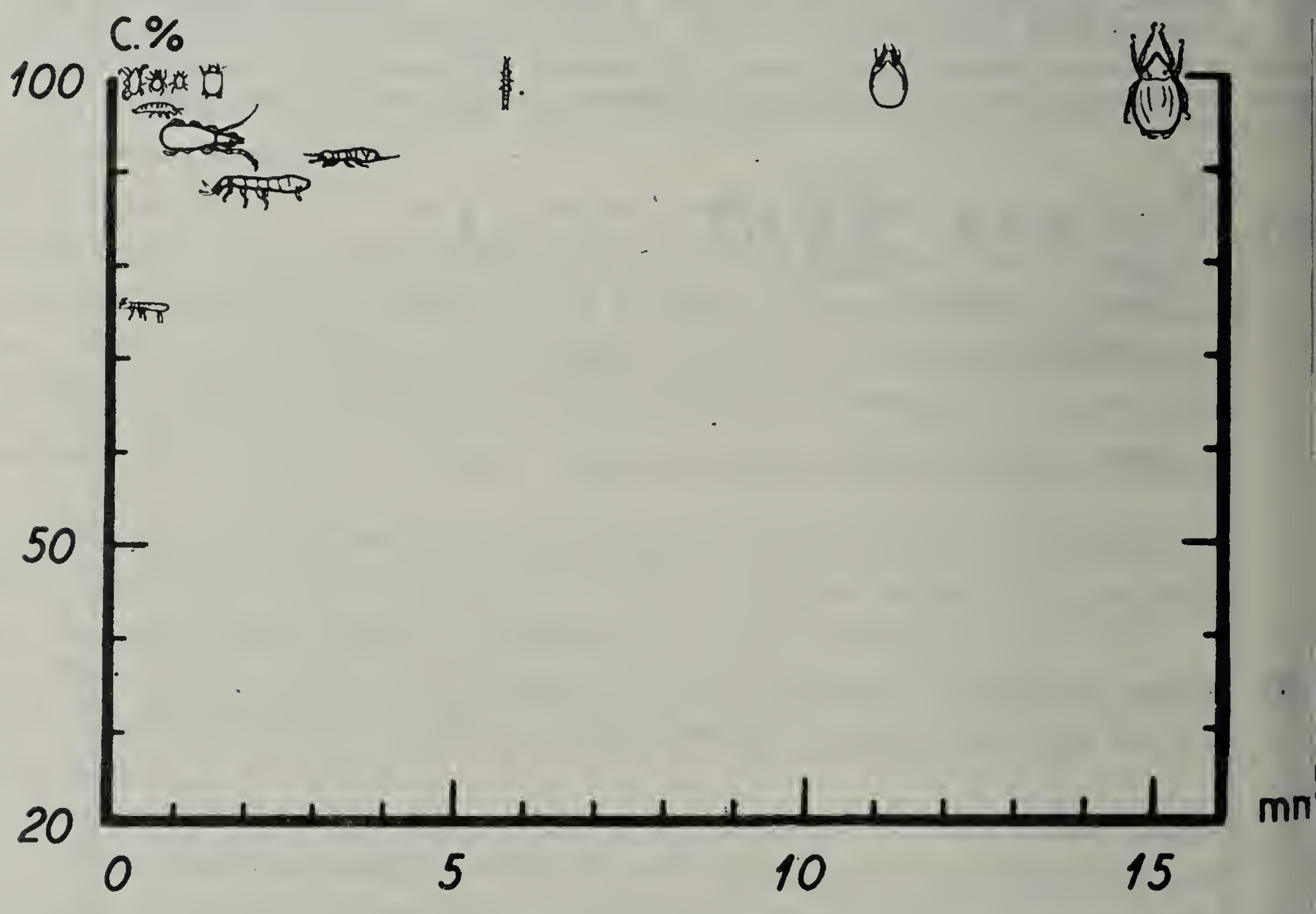


Fig. 2b. See text under III.

IV – The fauna pictures mentioned have only dealt with few species from each habitat. Now I will consider all the species from each of them. Again only the forest population will be mentioned. All the species collected in forest have been divided into five groups of constancy, corresponding to the five black columns of fig. 3. It shows f.inst. that 53 species have a constancy lower than 20%, 14 a constancy higher than 80% (with size of sample = 1/1000 m^2).

In the columns to the right on the same diagram you find the same constancy groups as before. Yet in each column, each of the species is multiplied with length and breadth and average number of the species per sample.

When of these groups the lowest and highest frequencies are compared, it is clearly demonstrated that the total surface of the animals in the last group is much larger than that of the first one, even though the group with the highest constancy contains much fewer species than the former.

For the solution of problems dealing with the activity of mites and collemboles in the soil, most of the species can consequently be ignored. Only species from the last column will be considered.

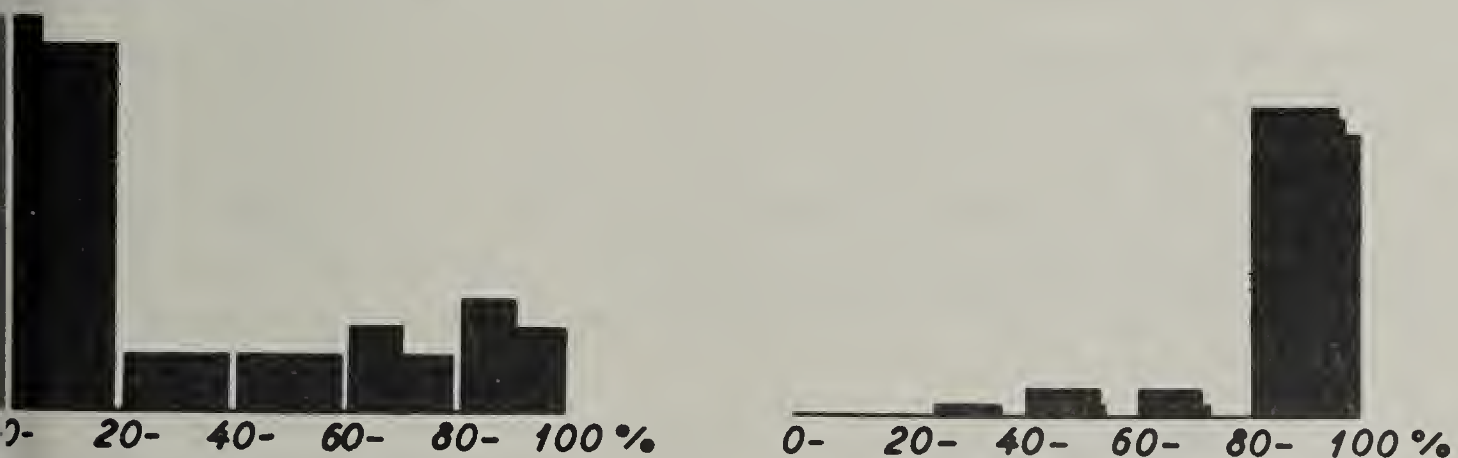


Fig. 3 – See text under IV.

SOME ECOLOGICAL STUDIES IN LEPTOTHORAX ACERVORUM L.

by

D. WRAGGE MORLEY

London, Great Britain

Summary

During the years 1946–9, ecological studies on *Leptothorax acervorum* were made both at Wytham Estate, on Howth headland, and in the New Forest. Although often classed as a "guest ant", *Leptothorax acervorum* does in fact occur very commonly on its own in districts where none of its host species are present, and it has been observed that its behaviour is remarkably different when found alone, than when it is found living near the nest of a host species such as the wood ant, *Formica rufa* L.

THE ROLE OF POPULATION LEVEL, FLIGHT PERIODICITY AND CLIMATE IN THE DISPERSAL OF APHIDS

by

C.G. JOHNSON
Harpenden, Great Britain

The movements of aphids by drift on the wind begins with the liberation of the alatae from food-plants and crops. It is therefore essential that in a general study of the aerial movements of these insects, the factors responsible for changes in numbers of insects in the air in the close proximity to food-plants should be elucidated: and that the numbers in the upper air should, if possible, be related to the changes in aerial density at crop level.

The numbers in the air at any time depend on the level of the alate population on crops and food plants and on the proportion of this population on the wing – i.e. on the degree of flight activity. It is the object of this communication firstly to describe briefly attempts to eclucidate these aspects as they occur near the crop and to show their relation to current weather conditions; and secondly to suggest how the situation on and near the crop may be linked with that of the drifting populations in the upper air.

I have used the changes occurring in aerial density of the alatae of *Aphis fabae* Scop. to illustrate the changing situation near the crop in relation to weather and population level.

For the second part, dealing with the situation in the upper air, I have considered all aphid species trapped up to a height of 2000 ft. above the ground.

The situation near the crop

Using a suction trap (JOHNSON, 1950), on a level with the top of bean crops, consecutive and continuous hourly records of density were obtained over a period of about 6 weeks. The general periodicity of aerial density change is a well marked diurnal one, commonly with two peaks during the day and a nightly quiescent state when virtually no flight occurs at crop level.

The dispersal of the largest numbers therefore occurs during the day and at night relatively few remain in the air. The density changes from hour to hour were at first thought to reflect parallel changes in the degree of flight activity and it was expected that an analysis of successive hourly catches would reveal strong relationships between temperatures, wind-speed and density: for wind-speed is known to exert a considerable effect on take-off, aphids being reluctant to commence flight in windy weather.

An analysis of hourly density changes, however, failed to show any statistically significant relation with wind-speed over a range of 0-22 m.p.h.

although temperature and density were positively and significantly correlated. It is doubtful if this lack of association of hourly change of density and wind-speed was due to the absence of an effect of wind upon take-off rates; and it is considered that a more likely explanation is, that the magnitude of population change from one hour to the next – whether due to rapidity of moulting of winged nymphs into alates or to the depletion of the alate population by flighting from the crop – is sufficient to obscure the changes in degree of flight activity, and thus to render this method of activity analysis suspect.

On the other hand it is usual to suppose that population changes are shown up more on running means than on differences between successive periods. It is therefore somewhat curious that the fluctuations in the running mean of log total caught/"½-day period" are more strongly correlated with the wind-speed than with any other meteorological factor.

It is suggested that the effects of wind-speed may, in this case, be twofold – namely an increase in wind-speed depressing the rate of take-off and also diluting the densities near the ground by elevating more insects to higher levels in the atmosphere.

In this respect it is pointed out that previous workers have always interpreted the effect of wind-speed on numbers in the air from trap catches a few feet from the ground.

If, as seems likely, increased wind-speed also causes a redistribution of aphids in the air, due to a greater degree of turbulent mixing, then a reading of density at a single low level will give no indication of the total changes in aphid content of the whole atmosphere up to at least several hundred feet.

The situation in the upper air

The task, seemingly impracticable, of assessing the insect content of the whole atmosphere, has recently been brought more within the bounds of possibility. By trapping simultaneously at various heights up to 2000 ft. on the cable of a barrage balloon it is found that the logarithm of aphid density plotted against the log. height is linear down to 10 ft. above the ground during the day up till 16.30 hrs; this conforms to the relation shown between density and height in the dispersal of small inert particles by turbulent diffusion (JOHNSON & PENMAN, 1951).

This result, apart from its significance on the mechanism of dispersal, allows the area under the density-height curve to be integrated and an estimate to be made of the total number of aphids in a zone between any two heights over a certain period of time.

It has been shown in this way, that although the *concentration* near the ground may be exceedingly high, the majority of the aphids in the air *during the day* are in fact in the zone above 10 ft. from the ground. For the period 08.30 – 16.30 hrs. during the summer of 1949, of the total aphid content of the air, 77% was above 10 ft. Thus the possibility of an integrated picture

of the total aerial situation in relation to terrestrial events is brought a stage nearer and the dispersal situation as a whole is brought into slightly sharper focus.

Literature

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DISCUSSION

Mr. **Haarløv:** I should like to know if the temperature is measured at the same place where the aphids are found.

Mr. **Johnson:** Yes, the temperature was measured in a meteorological screen placed inside the crop.

Mr. **Richards:** Is it possible to relate the depletion of the population of alates on the leaves to the numbers of alate forms caught flying?

Mr. **Johnson:** It has not been possible to do this but the relation has been put forward as a probable explanation of the observed facts.

Mr. **Buxton:** You have difficulty in showing a correlation between airborne population and certain physical factors. This might be due to a diurnal change in physiology of the bean plant, and therefore in *Aphis* behaviour. Have you isolated your data for certain times of day, and then attempted to study this correlation?

Mr. **Johnson:** Yes, I have done that. The complexity is not in any degree eliminated.

Mr. **Jary:** a. Do the observations relate entirely to *Aphis fabae?*
b. Do the observations relate to *A. fabae* alatae from winter host, i.e. *Euonymus* or not?

Mr. **Johnson:** a. Up to 10' from the soil level, to *A. fabae* only; over 10' to miscellaneous species.
b. The alatae were those arising from a crop of beans in the summer.

UEBER DIE BEI PIERIS BRASSICAE L., IHREN PARASITEN UND HYPERPARASITEN SCHMAROTZENDEN MIKROSPORIDIEN

von

HANS BLUNCK

Bonn, Deutschland

Ueber die bei *Pieris brassicae* L. vorkommenden Protozoonosen ist bislang wenig bekannt. Nur PAILLOT (1918, 1924, 1929) hat dazu einigen Grund gelegt. Er war es auch, der bei *P. brassicae* Mikrosporidien beobachtete. Er fand nach und nach 4 Spezies, nämlich 3 Vertreter der Gattung Perezia und eine aus der Gattung Thelohania. FAURE (1926) und BOESE (1936) haben die Angaben in einigen Einzelheiten ergänzt, zum Teil auch abgewandelt, aber zwischen den einzelnen Arten nicht oder nicht so scharf unterschieden. FAURE fand auch *Apanteles glomeratus* L. und *Trichogramma evanescens* Westw. befallen.

Mir selbst sind Mikrosporidien in *Pieris*-Material (1935, 1950 und 1951) begegnet. Ein Fund aus Duisdorf bei Bonn betraf 1951 auf Thelohania mesnili Paillot. Bei dem restlichen Material erwies sich aber die Homologisierung mit bekannten Arten unmöglich. Es fehlt nämlich anscheinend das für Thelohania und Perezia charakteristische Sporoblastenstadium. Das Material dürfte daher bei Nosema einzureihen sein.

Ueber Thelohania mesnili ist wenig Neues zu sagen. Wir fanden die Art nur bei 3 Raupen von *Pieris brassicae,* die der Grösse des Kopfes nach auf L IV, dessen Färbung nach aber auf LV zu beziehen, also vermutlich im Wachstum zurückgeblieben waren. Sie gingen unter Erbrechen oder Ausscheiden von flüssigem Kot ein. Alle 3 waren apantelisiert. Der Befall beschränkte sich bei ihnen auf das abnorm voluminöse und auffällig weissgelbe Corpus adiposum. In diesem liessen sich die ursprünglichen Zellen nur noch schwer abgrenzen. Sie schienen auf mehrere 100 μ Durchmesser aufgetrieben und dann grossenteils geplatzt zu seien. Ihr Inhalt bestand so gut wie ganz aus den schon bei Untersuchung des lebenden Objekts auffallenden, überaus charakteristischen, kugeligen, 7–8 μ im Durchmesser haltenden Sporoblasten. Versuche, die Infektion durch Bestreichen von Blattfutter mit einer wässerigen Aufschwemmung von Sporen auf andere Raupen zu übertragen, misslangen. Der Befund stimmt in allen Teilen zu der von PAILLOT (1924) fur Thelohania mesnili gegebenen Beschreibung. Zusätzlich ist zu bemerken, dass der Befall offenbar perniziös war, dass dieser Mikrosporidie aber keine wirtschaftliche Bedeutung zukommt. Sie ist dazu viel zu selten. Auch PAILLOT ist ihr nur 2 mal begegnet.

Weiteres Mikrosporidienmaterial lieferten in den 3 Beobachtungsjahren verseuchte Raupen von *Pieris brassicae* aus Schleswig-Holstein. Dazu kamen 1950 uns im Januar aus Wittenau bei Berlin von Herrn Dr G. SCHMIDT, Dahlem, gesandte infizierte Kokons von *Apanteles glomeratus* L. Das

augenfälligste Kennzeichen waren auch dabei die Sporen. Trotz ihrer Kleinheit sind sie dank dicker Beschalung, starker Lichtbrechung und einer meist deutlich schon am lebenden Objekt sichtbaren polständigen Vakuole auffällige Gebilde.

Gestaltlich waren die Sporen nicht einheitlich, Bei weitem der häufigste Typ ist schlank-ovoid, fast stäbchenförmig (Abb. 1A, C, E, F), oft mit 1–2 Vakuolen, die schon im Leben erkennbar sind. Er misst in der Länge 4–4½ µ, im Durchmesser 1½ µ, doch kommen – eine bei Mikrosporidien häufige Erscheinung – auch etwas kleinere und wesentlich grössere Stücke vor. Man hat bei Extremen solcher Art wohl von Zwerg- und Riesensporen gesprochen. Das mag zur rein sprachlichen Scheidung zulässig sein, es wäre aber abwegig, in den extremen Formen mehr als durch Umweltverhältnisse bedingte Modifikationen zu sehen.

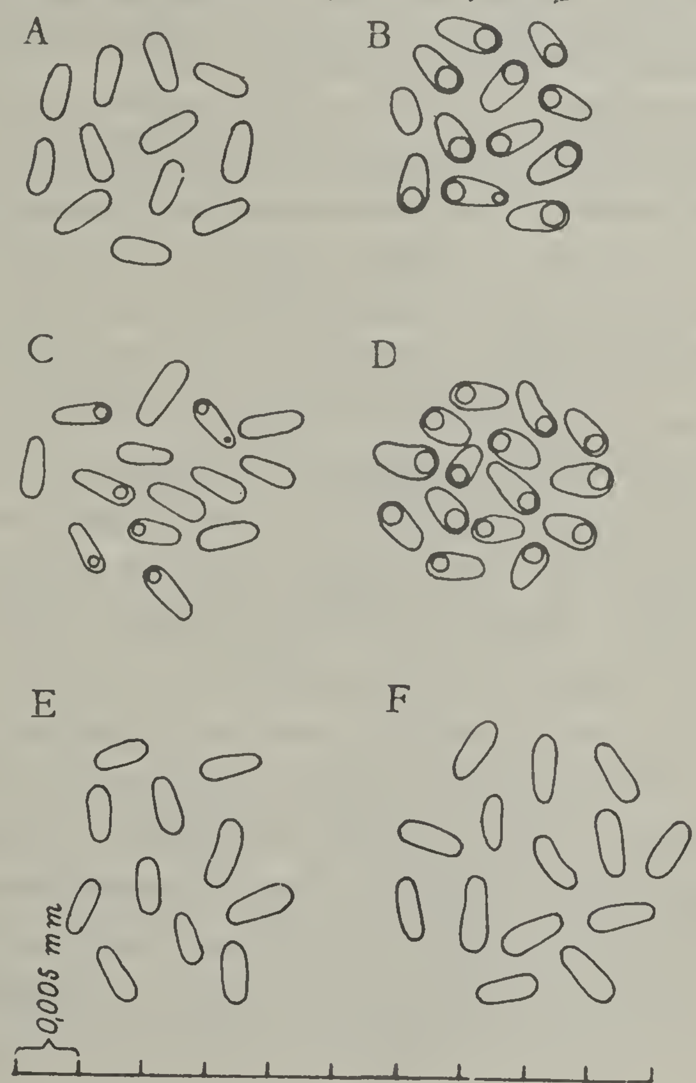

Abb. 1

A. *Pieris brassicae* L., Puppe. Sporen aus Faeces im Darm.
B. *Pieris brassicae* L., Altlarve. Sporen aus Riesenoenocytoiden im Blut bei *Apanteles*-Befall.
C. und D. *Apanteles glomeratus* L., Altlarve. Sporen aus Körperbrei.
E. *Hemiteles fulvipes* Grav., Imago. Sporen aus dem Bauchmark.
F. *Tetrastichus rapo* Walk., Imago. Sporen im Körperbrei.

Nicht so sicher sind wir in dieser Beziehung bei einem 2. Typ, bei dem die Sporen zwar auch stark lichtbrechend und volumenmässig etwa ebenso gross aber relativ dicker, nämlich eiförmig (Abb. 1 B,D) sind. Sie halten in der Länge durchschnittlich 3½–4 µ, nie über 4½ µ, und im Durchmesser 2 µ. Ihre am breiteren Pol gelegene Vakuole ist meist relativ grösser als bei dem Stäbchentyp, und wiederholt war auch am entgegengesetzten Pol eine, dann kleinere Vakuole erkennbar (Abb. 1B).

Beide Sporenformen können im gleichen Individuum auftreten, wir fanden sie aber nicht nebeneinander in derselben Zelle. Bei den breit-ovoiden Exemplaren hatten wir oft den Eindruck, dass es sich um unreife Stadien handelte, wir fanden sie aber auch in offenbar voll ausgereiftem Material, zum Beispiel in ausgeworfenen Kotbrocken der Raupen, häufiger allerdings intrazellulär. Da Infektionsversuche mit ihnen uns wiederholt den Ausgangstyp lieferten, sprachen wir sie zunächst als Vertreter einer selbständigen Spezies an, wurden aber wieder stutzig, als in einem Fall nach Verabreichung der ovoiden Form

im Wirtstier nur Stäbchen zur Ausbildung kamen. Die Entscheidung, ob eine, 2 oder gar mehr Spezies vorliegen, muss also noch ausgesetzt werden.

Zur Weiterentwicklung scheinen die Sporen ihren Wirt zu verlassen und in einen neuen gleicher oder anderer Art eindringen zu müssen. Bei künstlicher Infektion, die bislang nur bei *Pieris brassicae* und *P. rapae* versucht wurde, gingen wir auf 2*) Wegen vor. Bei dem 1. wurde eine wässerige Aufschwemmung von Körperbrei stark infizierter Wirtstiere auf Kohlblätter aufgestrichen, die dann den Raupen als Futter gereicht wurden. Beim 2. Verfahren beschränkten wir uns darauf, die Raupen in Zuchtbehälter zu bringen, in denen vorher befallene Wirte gehalten waren. Beide Verfahren führten in der Regel bei beiden Wirten zum Erfolg, sofern die Raupen noch jung genug waren. Ob sie apantelisiert waren oder nicht, war dabei gleichgültig. Diese Feststellung ist insofern von Belang, als PAILLOT nur bei Raupen, die die Larven dieses Braconiden enthielten, auf Befall stiess. Infektion durch Verfütterung versuchter Nahrung ist also möglich. Der Befall in nicht mit künstlich infiziertem Futter, aber nach Haltung in mehr oder minder lange vorher mit verseuchten Raupen beschickten Zuchtzylindern könnte für Infektion durch die Haut sprechen. Wahrscheinlicher hatten sich die Versuchstiere aber beim Umherkriechen am Glas die Mundteile beschmutzt und dann die Sporen ebenfalls per os aufgenommen.

Versuche zur Infektion anderer Lepidopteren, wie *Cheimatobia brumata* L. und an Kohl lebender Noctuiden, misslangen. Befallen wurden dagegen verschiedene Parasiten- und Hyperparasiten-Arten der beiden Pieriden. Diese dürften sich durch Aufnahme der Sporen mit der Nahrung infizieren und zwar schon im Larvenstadium, also in ihrem Wirt.

In Bezug auf die besiedelten Organe und die pathologische Auswirkung des Befalls verhalten sich die Wirte nicht einheitlich. Allgemein gilt aber, dass die Wirtszellen ebenso wie bei Infektion durch andere Mikrosporidien zu Riesenwuchs neigen. Zellen von 100 und 200 µ Durchmesser sind nicht selten, vereinzelt wurden sogar solche beobachtet, die querüber 1/3 mm, wenn nicht mehr massen. Cytoplasma und Kern waren oft restlos aufgezehrt. Zum mindesten waren sie vielfach nicht mehr nachweisbar. Nur die Zellmembran blieb erhalten. Im übrigen füllten die Parasiten den Raum vollständig aus. Das bedeutet, dass die grössten Wirtszellen Tausende und Hunderttausende von Sporen bergen können. So zusammengeballt wirken diese dann wegen ihres starken Lichtbrechungsvermögens porzellan- oder kreideweiss. Die grössten Zellen sind mit blossem Auge sichtbar. Werden die Sporen in Massen frei und gelangen sie dabei in das Blut der Raupen, so trüben sie dieses milchig.

*) Anmerkung bei Indruckgabe des Manuskripts: Inzwischen gelang die Infektion bei *P. brassicae* auch dann, wenn wir die jungen Raupen mit Vollkerfen von *Apanteles glomeratus* L. zusammenbrachten, die vorher 1–2 Tage in einem Glaszylinder gehalten waren, dessen Wand und Boden mit einer Aufschwemmung von Sporenmaterial bestrichen war. In mehreren Fällen war dann später u.a. das Mitteldarmepithel der Raupen befallen, in einem Fall war der Darm aber frei während das Blut und vor allem die für *Apanteles*-Befall charakteristischen Riesenoenocytoide in diesem schwerstens verseucht waren. Das könnte dafür sprechen, dass die Wespen die Raupen nicht nur durch Verschleppen und Wiederabstreifen von Sporen über das Futter, also per os, sondern auch direkt beim Anstechen infiziert hatten.

Pieris brassicae L. gehört zu den mit am stärksten und vielseitigsten heimgesuchten Wirten. Bei seinen Raupen fanden wir fast alle Organe besiedelt, nämlich die Darmwandung, die Vasa Malpighi, die Seidedrüsenschläuche, (Abb. 2A), die Ganglien mit ihren Kommissuren, die Geschlechtsdrüsen, das Corpus adiposum und die Oenocyten.

Am häufigsten und wohl meist zuerst trifft der Befall das Mitteldarmepithel. Ebenso wie in anderen Organen können dann im Magen schwerstens heimgesuchte Zellen inmitten völlig gesunder Bezirke liegen. Der Parasit scheint sich also in seiner Wirtszelle so lange weiterzuvermehren, bis Nahrungsverknappung zur Sporogonie führt und dann die letzten Planonten zum Auswandern veranlasst. Fortschreitende Neuinfektion setzt sich über das Reifen der ersten Sporen hinaus noch lange fort, sodass schliesslich ausgedehnte Darmpartien geschlossen verseucht und milch- oder kreideweiss verfärbt sind. In extremen Fällen hatten wir den Eindruck, dass bis zu 80% der Magenwandmasse wenn nicht noch mehr aus Mikrosporidiensporen bestand. Alsdann waren stets auch andere Organsysteme in Mitleidenschaft gezogen, vor allem Haemolymphe und Blutzellen. Befallene Oenocyten gewinnen streng kugelige Form und wachsen auf 10–30 µ Durchmesser (Abb. 2B), zuweilen noch stärker heran. Sie erlangen dann einen ganz ähnlichen Aspekt wie die für *Apanteles*-Befall bezeichnenden Riesenzellen des Bluts, die aber schon von Haus aus grösser sind und nicht selten 100–200 µ im Durchmesser halten. Auch diese Zellen werden aber befallen und zwar entweder im toto oder nur in einzelnen Partien (Abb. 1B, 2B). Wieder kann die ursprüngliche Substanz praktisch vollständig zum Schwinden kommen, und wieder enthält dann eine einzige Wirtszelle Tausende und Abertausende, wenn nicht Millionen von Mikrosporidien-Sporen. Vom Blut aus dürfte die Infektion weiterer Organe erfolgen, so auch die der Vasa Malpighi. Verseuchte Zellen wachsen dabei wieder weit über normal heran und wölben sich als weisse Knötchen nach aussen vor. Ein noch auffälligeres Bild liefern befallene Spinndrüsenschläuche. Da sie von Haus aus durchsichtig und farblos sind, treten die verseuchten Partien noch mehr als weisse, rundliche oder längliche Flecke als in den Malpighischen Gefässen hervor (s. Abb. 2A). Weniger häufig als bei den Hymenopteren (S. 436-37) stiessen wir im Fettkörper auf besiedelte Zellen. Nur einmal fanden wir eine Raupe, bei der auch das Nervensystem befallen war. Ueberraschenderweise erwiesen sich bei einer anderen auch die Anlagen der Geschlechtsdrüsen ziemlich stark mit Sporen durchsetzt. Immer befallfrei scheint die Muskulatur zu bleiben. Dieser Befund ist insofern bemerkenswert, als mindestens 2 der 4 von PAILLOT beschriebenen Mikrosporidien-Arten auch vor diesem Organsystem nicht Halt machen.

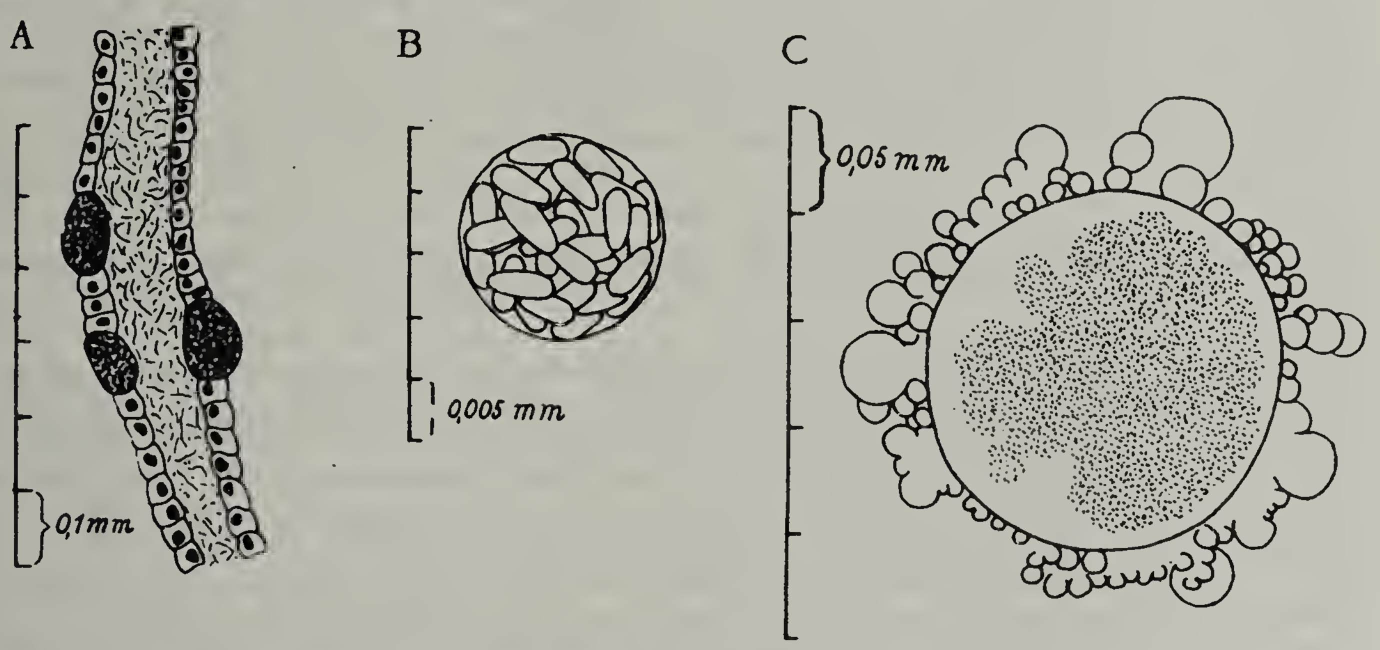

Abb. 2 – A. *Pieris brassicae* L., 3. Larvenstadium. 3 Riesenzellen mit Sporen im Spinndrüsenschlauch. B. *Pieris brassicae* L., Oenocytoid mit Sporen aus dem Blut einer apantelisierten Altraupe. C. *Pieris brassicae* L., Riesenoenocytoide in Kappen-Plasmolyse mit Sporen aus dem Blut einer apantelisierten Altlarve.

Sofern die Raupen zur Verwandlung gelangen, wird der Parasit mit in die Puppe übernommen (Abb. 1A). Des öfteren begegneten uns auch befallene Falter. Dass diese von aussen her infiziert werden, ist schwerlich anzunehmen. Wahrscheinlich übernehmen sie den Schmarotzer aus verseuchten Puppen.

Von der Infektion bis zum Auftreten der ersten Sporen vergehen bei *Pieris brassicae* höchstens 8–14 Tage.

Befallenes Material von *Pieris rapae* L. begegnete uns wiederholt. Der Parasit besiedelt im wesentlichen die gleichen Organe wie bei *P. brassicae.*

Den häufigsten Parasiten der *Pieris*-Raupen, also die Braconide *Apanteles glomeratus* L., hat schon PAILLOT (1933) mit Mikrosporidien-Befall in Verbindung gebracht. Er meinte aber, dass die Sporen, welche die Larven mit der Nahrung aufnehmen, unverändert den Darm passieren. FAURE kam zu einem etwas anderen Ergebnis (1926). Er schreibt, dass die *Apanteles*-Larven zwar im allgemeinen die Krankheit nicht auf sich ziehen, dass, falls es zu Befall kommt, aber eine gewisse Steigerung der Sterblichkeit eintritt, besonders bei den im Kokon überwinternden Individuen. Nach BOESE (1936) gehen die in die Darmwand eingedrungenen Stadien über kurz oder lang zu Grunde. Sofern wir die an unserem Material gemachten Beobachtungen auf jene Objekte übertragen dürfen, die den genannten Autoren vorgelegen haben, scheint FAURE den tatsächlichen Verhältnissen am nächsten gekommen zu sein. Die aus unseren befallenen Raupen erzogenen *Apanteles*-Larven waren aber nicht nur gelegentlich, sondern oft besiedelt (Abb. 1 C,D).

Sie führten dann nicht nur Sporen im Darmlumen sondern auch intrazellulär in den Organen und zwar in solchen verschiedener Art, nämlich u.a. in der Mitteldarmwand und im Corpus adiposum. Auch dort scheinen sie in Riesenzellen zu entstehen. Die Puppen stossen ein gut Teil der Sporen bei der Häutung zum Vollkerf ab, oder lassen sie, genauer gesagt, in der Exuvie, vor allem in dem von der Intima des Enddarms gebildeten chitinösen Schlauch zurück. Auch die Imago kann aber noch stark verseucht sein. Wieder häufen sich bei ihr die Sporen in dann stark anschwellenden Zellen des Magenepithels, weniger in der Wandung des Enddarms. Nie fanden wir sie in den Vasa Malpighi, stark dagegen wiederum im Corpus adiposum. Die Bauchganglien sahen wir bislang selbst bei starker Besiedlung anderer Organe freibleiben, während die Hoden mindestens einmal befallen waren. Während einige Zellen in diesen prall voller Sporen sassen, hatten andere, hart benachbart liegende, in der Sperma-Produktion fortgefahren. Frei bewegliche Spermatozoen waren reichlich vorhanden.

Die bei *Pieris rapae* L. schmarotzende und dort *Apanteles glomeratus* vertretende solitäre Braconide *A. rubecula* Marsh. fanden wir ebenfalls befallen.

Ueberraschenderweise stiessen wir auch und besonders oft bei Hyperparasiten des Kohlweisslings auf Befall, und zwar offenbar auf die gleichen Erreger. Das gilt vor allem für *Hemiteles fulvipes* Grav. (Abb. 1 E), also für den häufigsten Ichneumoniden unter den Schmarotzern von *Apanteles glomeratus.* Damit wurden erstmalig Mikrosporidien aus echten Schlupfwespen bekannt. Weit weniger oft war der seltenere *Hemiteles simillimus sulcatus* befallen und auch dann nur im männlichen Geschlecht. (BLUNCK 1951).

Bei *H. fulvipes* traf die Parasitierung vor allem das Corpus adiposum und in diesem die grossen, schon mit blossem Auge sichtbaren Uratzellen, kaum minder stark aber auch den Mitteldarm, seltener die Ganglien und die Hauptnervenstränge (Abb. 1E), in die der Parasit aber oft ziemlich tief eingedrungen war. Zu streckenweise

völliger Aufzehrung der Nervensubstanz war es allerdings nie gekommen. Einen bevorzugten Sitz des Schmarotzers bildeten die männlichen Geschlechtsorgane. Es kam vor, dass sämtliche Bildungszellen der Hoden mit Sporen vollgepfropft waren, die Sperma-Produktion also vollständig aufgehört hatte. Wider Erwarten suchten wir in den Malpighischen Gefässen vergeblich. Die Ovarien waren nicht besiedelt. Auch befallene Weibchen produzieren übrigens normale Eier.

Ein einziges Mal kam uns auch ein Vertreter der Gattung *Gelis* (syn. *Pezomachus*), also jener eigentümlichen, nach Grösse und Form infolge ihrer Flügellosigkeit an Ameisen erinnernden Ichneumoniden-Gruppe, mit Befall unter die Präpariernadel. Es handelte sich um ein Weibchen von *G. transfuga* Forst., die ebenfalls bei *Pieris brassicae* hyperparasitiert und ziemlich häufig ist, aber biologisch bislang unbekannt blieb. (BLUNCK 1951). Die kleine, die *Apanteles*-Larve schon in der Raupe befallende Zehrwespe *Tetrastichus rapo* Walk. fanden wir ebenfalls mehrfach verseucht. Die Sporen (Abb. 1 F) waren dann vom gleichen Typ wie in Larven von *Apanteles glomeratus* aus demselben Kokonmaterial. Letzteres stammte aus nachweislich verseuchten, von uns teilweise künstlich per os infizierten Raupen von *Pieris brassicae.*

Die Auswirkung von Mikrosporidien-Befall auf seine Träger ist sehr unterschiedlich: Während die durch Nosema bombycis bewirkte Pébrine der Seidenraupe und der Nosema-Befall der Honigbiene gefürchtet sind, sind andere Mikrosporidien ziemlich harmlos. Gewisse, bei holzfressenden Schmetterlingsraupen lebende Nosema-Arten sind seinerzeit von PORTIER sogar für Symbionten gehalten, eine Auffassung, die später allerdings von SCHWARZ (1929) zerstört wurde. Wir fühlten uns daran erinnert, als wir bei den das Blut angestochener *Apanteles*-Larven aufleckenden Weibchen von *Hemiteles simillimus sulcatus* vergeblich nach Mikrosporidien suchten, während wir, wie gesagt, die sich auf diesen Eiweisserwerb nicht verstehende Nachbarart *H. fulvipes* fast immer besiedelt fanden. Symbiontisch lebende Sporozoen sind aber unseres Wissens bislang nicht bekannt geworden, und bald stellte sich heraus, dass auch unsere Mikrosporidien nichts anderes als echte Parasiten sind.

Das lehrte schon die Zellularpathologie. Alle besiedelten Wirtszellen leiden schwer. Die meisten werden nach und nach völlig zerstört, auch dann, wenn sie zunächst mit Riesenwuchs reagieren. Das ist bei allen Geweben dasselbe. Es kann aber nicht ausbleiben, dass diese geschädigt werden. Schwacher Befall ist den Tieren allerdings nicht anzumerken. Sie halten sich sogar dann noch erstaunlich lange, wenn schon ein hoher Prozentsatz der Zellen wichtiger Gewebe ausgeschaltet ist. Dass besiedelte Schlupfwespenweibchen noch entwicklungsfähige Eier legen, wurde schon erwähnt. Bei den Männchen geht die Sperma-Produktion selbst dann weiter, wenn ein gut Teil der Bildungszellen schon ganz zerstört ist. Es darf daraus geschlossen werden, dass diese Sporozoen keinesfalls Toxine ausscheiden. Sie vergiftigen ihre Opfer nicht, sondern leben auf deren Kosten gewissermassen räuberisch. Nur das macht verständlich, dass die intakt gebliebenen Zellen auch dann weiterarbeiten können, wenn sie mitten zwischen zerstörten liegen. Solange der Gewebeschwund nicht gar zu gross ist, können die Wirte die Metamorphose beenden und sich sogar weiter fortpflanzen. Diese Toleranz hat allerdings ihre Grenzen. Sehr schwerer und genereller Befall wirkt lebenverkürzend.

Unsere *Hemiteles*-Wespen, die sich unter günstigen Bedingungen monatelang hielten, gingen bei Befall trotz guter Pflege zuweilen frühzeitig ein. Ihre Nachkommenschaft blieb dann entsprechend gering. Stärker befallene *Apan-*

teles-Larven schienen zu verzwergen und höchstens noch dünnwandige Kokons liefern zu können. Bei *Pieris brassicae* brachten manche Raupen es nicht zur Verwandlung. Dass unsere Kohlweisslingsraupen den Befall durch Thelohania mesnili nicht überlebt haben, wurde schon erwähnt. Auch die durch Nosema heimgesuchte *Pieris*-Brut ging aber z.T. schon vor Erreichen des Altlarvenstadiums unter Entwicklungsverzögerung und Verzwergungserscheinungen zu Grunde. Hoch war der Prozentsatz krepierender, verseuchter Puppen. Infiziert befundene Falter hatten ebenfalls nicht lange gelebt. Alles in allem: Die hier zur Erörterung stehenden Mikrosporidien sind entscheiden pathogen. Wir stellen daher zur Erörterung, ob sich etwa ihre Einfuhr nach Amerika und Australien zwecks biologischer Bekämpfung der dort so schädlichen *Pieris rapae* lohnt.

Es bleibt noch ein Wort über die systematische Bewertung der hier behandelten Mikrosporidien zu sagen. In Bezug auf Thelohania mesnili Paillot dürfte die Lage klar sein. Gattung, Spezies und Name liegen eindeutig fest. Wohin aber gehört das restliche Material? Hier wird das letzte Wort wohl erst nach weiterer Klärung des Entwicklungsgangs, der Schizogonie wie der Sporogonie, gesprochen werden können. Schon jetzt ist aber sicher, dass diese Formen, gleichgültig, ob sie auf eine oder mehrere Arten zu beziehen sind, sofern sich nicht doch noch Sporoblasten finden, zur Gattung Nosema gehören, und wir schlagen auf die Gefahr hin, dass sich später eine weitere Aufteilung als nötig, oder eine Homologisierung mit einer oder der anderen von PAILLOT studierten Arten als möglich erweisen sollte, als Speziesnamen **N.polyvora** vor.

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DIE BEDEUTUNG DER TERRICOLEN ARTHROPODEN FÜR BODENBEURTEILUNG UND BODENVERBESSERUNG

von

H.FRANZ

Admont, Österreich

Die Bodenbiologie hat in den letzten Jahrzehnten eine stürmische Entwicklung mitgemacht. Sie hat zu Erkenntnissen geführt, die für die Bodenkunde wie für die Pflanzenernährungslehre in gleicher Weise grundlegende Bedeutung haben und die erkennen lassen, dass in der land- und forstwirtschaftlichen Bodenpflege und -nutzung in der Vergangenheit schwere Fehler gemacht worden sind. Diese Fehler in Zukunft zu vermeiden ist angesichts des Rückganges der Fruchtbarkeit unserer Kulturböden und des ständigen Anwachsens der menschlichen Bevölkerung der Erde ein dringendes Gebot der Stunde. Es ist daher eine zwingende Notwendigkeit, die gewonnenen biologischen Erkenntnisse so schnell wie möglich in der wirtschaftlichen Praxis auszuwerten, das heisst, in dieser neben den bisher ganz vorwiegend angewandten physikalischen und chemischen Arbeitsmethoden in weitaus grösserem Umfange als bisher auch biologische anzuwenden.

Man steht heute in einer ganzen Reihe von Kulturstaaten bereits im Begriffe, dies zu tun und wird sich dabei bewusst, dass den jeweiligen Umweltbedingungen entsprechende biologisch richtige Methoden der Bodenpflege und -nutzung allenthalben erst entwickelt werden müssen. Zugleich zeigt es sich, dass unsere Kenntnis von den die Bodenfruchtbarkeit beeinflussenden biologischen Prozessen noch immer sehr unzulänglich ist und dringend der Ergänzung bedarf. Der Forschung erwachsen damit ständig neue, oft sehr umfangreiche Aufgaben, die mit den vorhandenen Fachkräften unmöglich in kurzer Zeit bewältigt werden können: der Arbeitsdruck, unter dem die bodenbiologische Forschung schon jetzt leidet, wird sich daher in Zukunft noch verstärken.

Mit der raschen Entwicklung der biologischen Erforschung des Bodens hat sich u.a. auch der Entomologie ein weites neues Arbeitsgebiet eröffnet, da ja ein sehr erheblicher Teil der terricolen Organismenarten Arthropoden sind. Auch auf entomologischem Gebiete ist aber die Zahl der Fachleute, die sich, zum Teile neben anderen Aufgaben, der speziellen Bearbeitung terricoler Insekten widmen, sehr gering, und die vorhandenen Arbeitskräfte reichen nicht annähernd aus, um die an sie gestellten Anforderungen befriedigen zu können. Selbst die Zahl der Spezialisten, die in der Lage wären, die vielfach sehr kleinen, schwer bestimmbaren, ja zum Teil noch unbeschriebenen terricolen Insekten zu determinieren, deckt den gegenwärtigen Bedarf in keiner Weise. Angesichts dieser Tatsachen muss alles unternommen werden, um einerseits durch internationale Zusammenarbeit auf dem Gebiete der bodenbiologischen Forschung eine möglichste Leistungssteigerung zu erreichen und anderseits durch Aufklärung der breiten Öffentlichkeit ein allgemeineres Verständnis für die Bedeutung dieser Arbeiten und für die Notwendigkeit ihrer finanziellen Förderung zu erwecken.

Zwei grosse Anwendungsgebiete sind es, die sich der Entomologie heute auf dem Gebiete der Bodenbiologie eröffnen: die biologische Bodenbeurteilung und die biologische Bodenverbesserung. Beide seien im folgenden kurz besprochen. Ich erörtere zunächst das Gebiet der biologischen Bodenbeurteilung.

Der Umstand, das die Bodenfauna hinsichtlich Individuenzahl und Arten-

zusammensetzung von Standort zu Standort in gesetzmässiger Weise wechselt, gibt uns die Möglichkeit, aus ihrer Zusammensetzung Schlussfolgerungen auf die natürlichen Standortsbedingungen und auf den jeweiligen biologischen Bodenzustand zu ziehen. Wie die Vegetationskunde an Hand bestimmter „Leitpflanzen" genaue Aussagen über das Standortsklima und bestimmte Eigenschaften von Boden und Grundgestein machen kann, so ermöglicht auch die Artenzusammensetzung der Bodenfauna entsprechende Rückschlüsse. Da die Bodenorganismen in der Erde leben, ist ihre Feststellung naturgemäss schwieriger und zeitraubender als die der Pflanzen, dafür reagieren die terricolen Organismen aber zum Teil empfindlicher auf Bodenunterschiede als diese und sie machen infolge ihrer weit grösseren Arten- und Individuenmannigfaltigkeit auch eine exaktere statistische Auswertung möglich. Da viele terricole Kleintiere ein sehr geringes Ausbreitungsvermögen haben, bleiben Veränderungen in der Zusammensetzung der Bodenfauna auch wesentlich länger erhalten als solche in der Flora, so dass es in vielen Fällen möglich ist, aus der rezenten Artenzusammensetzung einer Bodensynusie Rückschlüsse auf Veränderungen zu machen, denen der betreffende Standort vor langer Zeit einmal unterworfen worden ist. Man kann demnach, wenn man die ökologische und historische Valenz einzelner Arten oder ganzer Artenverbindungen kennt, mit ihrer Hilfe gleichsam im Boden wie mit Schriftzeichen „lesen". Wir stehen im Begriffe, die Voraussetzung einer so weitgehenden biologischen Bodendiagnose für das Gebiet der Ostalpen zu schaffen, und es wäre ausserordentlich zu begrüssen, wenn entsprechende Vorarbeiten durch vergleichende biocoenotische Untersuchungen auch in anderen Gebieten geleistet würden.

Die Besatzdichte eines Bodens mit Organismen gibt, sofern man nicht bloss eine Tiergruppe, sondern alle in grösserer Individuenzahl vorhandenen berücksichtigt, ein gutes Bild vom Fruchtbarkeitszustand eines Bodens. Fruchtbare, humusreiche und in der oberen Schicht lockere Böden sind dicht mit tierischen Organismen besiedelt, nährstoff- und humusarme sind dagegen tierarm. Die quantitative Ermittlung des Kleintierbesatzes ergibt daher, zum gleichen Zeitpunkte und nach derselben Methode festgestellt, ein recht verlässliches Vergleichsmass für die Bodenfruchtbarkeit. Das hat weniger für die Ermittlung des Bodenwertes (Taxation) als für die Beurteilung des biologischen Erfolges künstlicher Massnahmen wie Ent- und Bewasserung, Bodenbearbeitung und Düngung, Schwarzbrache und Bodenbeschattung, praktische Bedeutung. Da die Besatzdichtenermittlungen Auskunft über den Massenwechsel der terricolen Kleintiere und in erster Annäherung auch über die Intensität der in einem bestimmten Boden ablaufenden biologischen Vorgänge geben, lässt sich aus ihnen die biologische Wirkung von Bodenpflege- und Bodennutzungsmassnahmen mit grosser Sicherheit ablesen.

Noch bedeutsamer als für die Bodenbeurteilung ist die Anwendung der biologischen Erkenntnisse für die Bodenverbesserung. Wir wissen heute, dass den terricolen Kleintieren nicht bloss für die ständige Durchmischung, Durchlüftung und Lockerung der obersten Bodenschichten, sondern auch für die Zersetzung des pflanzlichen Bestandesabfalles und seine Umwandlung teils in Humus, teils in letzte Abbauprodukte der organischen Substanz, vor allem CO_2, grösste Bedeutung zukommt. For-

schungen der allerletzten Jahre haben uns ferner gezeigt, dass die Bodenkleintiere auch an der Stickstoffernährung der grünen Pflanzen und an ihrer Versorgung mit Wuchsstoffen lebhaften Anteil haben, dass sie also den Stoffkreislauf zwischen Boden und Vegetation nicht bloss durch Freimachung der in den organischen Abfallstoffen enthaltenen Mineralstoffe, sondern darüber hinaus auch durch Bereitstellung zusätzlicher Nähr- und Wirkstoffe in Gang halten. Hierbei stehen die Bodenkleintiere offenbar in enger Wechselwirkung mit pflanzlichen Mikroorganismen. Bakterien und Pilze leiten zumeist die Zersetzung des frischen Bestandsabfalles ein, bevor dieser von Arthropoden und anderen Bodentieren als Nahrung zerkleinert und aufgenommen wird. Pflanzliche Mikroben haben weiterhin in den meisten Fällen an der Aufschliessung der Nahrung in den Verdauungsorganen der Arthropoden und anderen terricolen Kleintieren wesentlichen Anteil. Mikroben setzen schliesslich auch den Umbau der organischen Substanz in Humus in den ausgeschiedenen Exkrementen der Tiere weiter fort. Durch eine Reihe von Arbeiten, die auf dem Gebiete der Humusforschung in den letzten Jahren veröffentlicht worden sind, besitzen wir Kenntnis davon, dass in den Verdauungsorganen der Bodenkleintiere und in den von ihnen ausgestossenen Exkrementen optimale Bedingungen für den Aufbau von Humusstoffen bestehen. Das im Zuge der Kohlehydratverdauung aus dem Zellverbande freigelegte Lignin kann hier bei gedrosselter Sauerstoffzufuhr mit den aus dem Eiweissabbau im Tierkörper und durch Autolyse von Mikroorganismen freiwerdenden Stickstoffverbindungen in Reaktion treten und durch stufenweise Autoxydation in Braunhuminsäuren übergeführt werden. In gleicher Weise werden die von den Bodenkleintieren während der Verdauung nicht verbrauchten Kohlehydrate unter Beteiligung von Mikroorganismen zu Humus umgebaut. Dabei entstehen unter Mitwirkung von Aktinomyzeten und Bakterien der Azotobakter-Gruppe z.T. auch stickstoffreiche Grauhuminsäuren, die später bei ihrer Aufspaltung den Pflanzen leicht aufnehmbaren Stickstoff zur Verfügung stellen. Dieser Stickstoff ist im Gegensatz zu den mineralischen Handelsdüngern eine langsam wirkende ideale Stickstoffquelle, die während der gesamten Vegetationszeit der Pflanzen nicht versiegt und offenbar eine der wichtigsten Komponenten der hohen Bodenfruchtbarkeit humusreicher Böden darstellt. Beim restlosen Abbau von Humus und frischem pflanzlichem Bestandesabfall sowie schliesslich bei der Atmung der Organismen werden beträchtliche CO_2-Mengen frei, die während der Vegetationszeit den Pflanzen unmittelbar für die Assimilation zu Gute kommen. Milder, durch Basen abgesättigter Humus begünstigt die Krümelung des Bodens, d.h. das lockere, hohlraumreiche Gefüge, er vermag aber infolge seiner hohen Sorptionskraft auch Wasser und leichtlösliche Mineralsalze zu speichern. Hochwertiger Humus besitzt daher für die Bodenfruchtbarkeit die allergrösste Bedeutung.

Ein bisher noch ganz unzulänglich erforschtes Kapitel betrifft die unmittelbaren Wechselbeziehungen zwischen Kleintieren, vor allem Arthropoden, und pflanzlichen Mikroben. Man weiss heute, dass viele Insekten in Symbiose mit Bakterien bzw. Hefepilzen leben und dass sie in vielen Fällen ohne Symbionten überhaupt nicht existenzfähig sind. Das wird damit erklärt, dass die Symbionten ihren Wirten Vitamine oder Wirkstoffe anderer Art zuführen und dass sie durch Autolyse einen beträchtlichen Teil des Eiweissbedarfes ihrer Wirtstiere decken. Von den Symbionten phytophager Rhynchoten und gewisser xylophager Käferlarven ist bekannt, dass sie molekularen Stickstoff aus der Luft und noch leichter Ammoniak zu fixieren vermögen. Dasselbe ist bei terricolen Arthropoden bisher noch nicht mit voller Sicherheit festgestellt, jedoch durch den Nachweis einer oft sehr formenreichen Mikrobenflora in deren Verdauungsorganen wahrscheinlich gemacht. Zudem gelang es mir kürzlich, Darmsymbionten der Landassel Tracheoniscus ratzeburgi, ferner solche der Myriopoden Glomeris connexa carpathica, Polydesmus complanatus illyricus und eines Juliden, sowie schliesslich Mikroorganismen aus dem Darm von *Pytho depressus* (Larve) und von *Lumbricus rubellus* in stickstofffreier Nährlösung zur Massenvermehrung zu bringen. Man geht demnach wohl nicht fehl, wenn man annimmt, dass die Beziehungen zwischen terricolen Arthropoden und pflanzlichen Mikroben für den Stickstoffhaushalt in der Natur nicht ohne Bedeutung sind.

Je tieferen Einblick wir in die Lebensweise der einzelnen Bodentierarten, in ihre Leistungen für die Humusproduktion bzw. den Humusabbau, ihre Wechselbeziehungen zu höheren Pflanzen und zu pflanzlichen Mikroben gewinnen, um so klarer wird es uns, dass jeder Organismus eine spezifische Funktion im Boden ausübt, und dass daher die biologische Leistung eines Bodens um so höher sein muss, je ausgeglichener und artenreicher die ihn bevölkernde Lebensgemeinschaft ist. Die Vielfalt der natürlichen Biocoenosen hat der Mensch aber durch gewaltsame Eingriffe in die Natur in hohem Masse zerstört, so dass wir in unseren Kulturböden heute oft nur noch Fragmente der ursprünglichen Synusien antreffen. Radikale Massnahmen wie übermässige Ent- oder Bewässerung, sehr starke Düngung vor allem mit mineralischen Düngemitteln, häufige und übermässig tiefe Bodenbearbeitung, Schwarzbrache, Kahlschlag und Aufforstung von Monokulturen im Walde, bewirken notwendigerweise an den betroffenen Standorten das Aussterben derjenigen Arten, die gegen Milieuveränderungen besonders empfindlich sind. Wollen wir unseren Böden die alte Fruchtbarkeit zurückgeben, dann müssen wir demnach die Vorbedingungen für ihre neuerliche Anreicherung mit nützlichen Bodenorganismen schaffen, ein Ziel, das wir nur auf Grund einer sehr eingehenden Kenntnis der im Boden wirksamen biologischen Gesetzmässigkeiten erreichen können. Die unbedingte Voraussetzung hiefür bildet aber die Aufnahme des Artenbestandes der Böden und die Erforschung der Ökologie und Ethologie der terricolen Organismenarten. Dass auf diesen beiden Gebieten allein, ganz abgesehen von der Erforschung der Symbiosen mit pflanzlichen Mikroben und ihrer Bedeutung für den Stoffhaushalt des Bodens, noch eine gewaltige Arbeit der Bewältigung harrt, ist jedem Eingeweihten klar.

Wir werden diese Arbeit nur auf dem Wege internationaler Zusammenarbeit in einigermassen annehmbarer Zeit zu leisten vermögen und ich glaube, wir sollten nicht länger säumen, diese Zusammenarbeit zu organisieren. Es bedarf zunächst eines Kataloges der terricolen Arthropoden einschliesslich aller jener Formen, die nur in einem aktiven Stadium im Boden leben. Wir benötigen ferner ein Werk, welches uns über die Ökologie und Verbreitung der einzelnen Arten Aufschluss gibt und wir müssen schliesslich nach im wesentlichen übereinstimmenden Methoden die Beschreibung der terricolen Lebensgemeinschaften in den verschiedenen Gebieten der Erde in Angriff nehmen. Erst wenn wir über diese Grundlagen verfügen, kann planmässige, biologisch richtige Bodenpflege betrieben werden, eine Bodenpflege, die nicht auf der einen Seite unbewusst zerstört, während sie auf der anderen gleichzeitig mühsam aufbaut. Dass es ohne intensives Leben keine Bodenfruchtbarkeit gibt und dass eine Steigerung der Bodenfruchtbarkeit auf die Dauer nur durch planmässige Förderung der in der Erde ablaufenden Lebensprozesse möglich ist, wissen wir heute; von einer soliden Kenntnis der Massnahmen aber, durch die wir die biologischen Kräfte des Bodens zu höchster Dauerleistung aktivieren können, sind wir noch weit entfernt.

DISCUSSION

Mr. **Mörzer Bruijns** Was sind Ihrer Meinung nach, die ersten Massnahmen, die zur Verbesserung degenerierter Bodenbiocönosen genommen werden müssen, weil es nicht möglich ist damit zu warten, bis die planmässigen Untersuchungen vollendet sind. In Holland sieht man im allgemeinen die Düngung mit organischem Material (Kompost) als sehr wichtig.

Mr. **Franz**: Obwohl wir heute viele Zusammenhänge noch zu wenig kennen, müssen wir doch sofort Massnahmen ergreifen. Schon heute steht fest, dass

eine Verbesserung des biologischen Bodenzustandes einerseits durch Anreicherung des Bodens mit hochwertigen Humusstoffen und andrerseits durch eine biologisch richtige Bodennutzung erreicht werden kann.

Die Humusanreicherung ist einerseits durch Humusdüngung, vor allem mit Stallmistkompost, und andrerseits durch Anreicherung des Bodens mit Wurzelmasse erreicht worden. Die Faktoren, die der Humusbildung förderlich sind, können in der verfügbaren Zeit leider nicht diskutiert werden. Es sei nur hervorgehoben, dass nicht bloss, wie bisher vielfach angenommen, die *Menge* der zugeführten organischen Substanz, sondern auch die *Qualität* derselben grösste Bedeutung hat. Wir haben u.a. gefunden, dass reine Mineraldüngung das Bodenleben sehr schädigt, dass diese schädliche Wirkung aber durch zusätzliche organische Düngung mit gut verrottetem Stallmist bezw. Stallmistkompost z.T. ausgeglichen werden kann.

Einen ausserordentlichen Einfluss auf das Bodenleben hat die Art der Bodennutzung. Unsere wichtigsten Ackernutzpflanzen, alle Getreidearten und unter den Hackfrüchten vor allem die Zuckerrübe, sind der Entwicklung des Bodenlebens wenig günstig. Überdies erweisen sich grosse Vegetationspausen zwischen zwei Früchten der Fruchtfolge als ausserordentlich schädlich, da der Mangel der Bodenbeschattung durch eine geschlossene Vegetationsdecke das Bodenklima sehr verschlechtert und auch den Humushaushalt des Bodens nachteilig beeinflusst. Wir haben nun durch Anbau von Zwischenfruchtpflanzen in den Vegetationspausen zwischen zwei Hauptfrüchten gute Erfolge erzielt. Das krümelige Bodengefüge konnte dadurch erhalten, ja noch gelockert werden, das Bodenklima wurde verbessert, und es wurde dem Boden zusätzlich organische Masse in Form von Wurzeln zugeführt. Bei Anbau von Leguminosen, Leguminosengemengen und Cruciferen (Raps, Rübsen) wurden besonders gute Ergebnisse erzielt und Ertragssteigerungen bei den nachfolgenden Hauptfrüchten bis zu 33% erzielt. Wir messen heute der Produktion grosser Wurzelmassen für die Bodenverbesserung grosse Bedeutung zu. Überdies sehen wir immer deutlicher, dass es für die Förderung der bodenbiologischen Prozesse wesentlich ist, dass bei Bodenpflege und -nutzung grosse Milieuveränderungen möglichst vermieden werden. Je mehr es nun gelingt auf dem Kulturlande kontinuierliche Standortsbedingungen zu schaffen, desto leichter wird es uns sein, grosse Schäden an den Bodenorganismen zu vermeiden. Dies gilt in gleicher Weise wie für die landwirtschaftlich genutzten Flächen auch für den Wald. Die moderne Forstwirtschaft nimmt auf diese Forderung von Erfahrungen an den Holzpflanzen ausgehend heute schon mehr Rücksicht als die Landwirtschaft, wird das aber in Zukunft durch Begründung standortsgemässer Mischbestände und Ersatz der Kahlschlagnutzung durch Plenterbetrieb noch mehr als bisher tun müssen.

ETUDE DU CYCLE BIOLOGIQUE DU COUVAIN CHEZ POLISTES

(Hymenoptères Vespides)

par

Ed.Ph. DELEURANCE

Paris, France

Les phases „couvain normal" et „couvain abortif"

L'évolution du couvain, chez *Polistes*, est étroitement conditionnée par la physiologie des guêpes (fondatrices et ouvrières). Celle-ci règle une évolution cyclique rigoureusement déterminée dans son déroulement. Des facteurs physiques externes, surtout la température, agissent secondairement: ils conditionnent l'importance relative des différentes phases du cycle. Dans le présent exposé, nous nous bornerons à étudier les deux phases que nous avons décrites sous le nom de „couvain normal" et „couvain abortif"

Au printemps, la fondatrice construit son nid et élève un couvain homogène qui donne naissance à des imago parfaitement constitués. Les guêpes-filles qui éclosent les premières n'ont pas de diapause: elles représentent les ouvrières. Elles „relaient" la fondatrice et élèvent à leur tour un couvain sain. Cette première phase de l'évolution du couvain dans la société *Polistes* constitue la phase „couvain normal". Elle est *essentiellement* caractérisée par la disposition régulière, homogène, des larves qui évoluent en quasi totalité, donnant des imago sans défauts.

Une deuxième phase va progressivement lui succéder, qui marque irrévocablement le déclin et la fin de la société: la phase „couvain abortif". A ce moment, en effet, les larves se montrent incapables d'évoluer normalement: elles avortent à des stades divers, principalement à la pupaison. La disposition du couvain devient anarchique. Les rares imago produits sont généralement anormaux. Une odeur typique se dégage du nid. Elle en provoque l'abandon par les guêpes: la société se dissout après destruction plus ou moins importante du couvain et du nid („massacre du couvain").

Nos observations et expériences montrent que cette évolution annuelle du guêpier est un phénomène complexe, étroitement lié à des facteurs nutritifs *qualitatifs*. En effet:

a) *toutes les vieilles guêpes sont incapables d'élever un couvain normal, malgré un apport de nourriture quantitativement normal.*

b) d'autre part, nos expériences sur la resection des canaux des glandes salivaires paraissent démontrer l'existence de substances, vraisemblablement oligodynamiques, produites par l'imago et servies aux larves. Les guêpes sont alors incapables d'élever un couvain normal.

c) enfin, le fait que le rajeunissement périodique de la population imaginale du nid (par adjonction de jeunes guêpes, ou par remplacement) maintienne un couvain normal, montre également l'importance des facteurs trophiques dans le phénomène.

éanmoins l'hypothèse d'une carence nutritive ne suffit pas à expliquer le ıénomène en totalité. Car d'une part, les larves nourries quelque-temps *clusivement* par des vieilles guêpes ne sont pas nécessairement „rétablies." 'autre part, des larves abortives réduites en bouillie et servies aux larves ıines peuvent provoquer l'avortement de ces dernières, qui présentent alors s symptômes du couvain abortif. Il semble donc qu'un agent pathologique ıtervienne dans ce cas. Il jouerait peut-être comme cause secondaire. L'étu- bactérienne que nous avons entreprise nous éclairera sans doute sur ce ɔint. Quoi qu'il en soit, ces observations montrent que l'avortement du cou- ıin est un phénomène complexe que la simple carence alimentaire ne suffit ıs à expliquer.*

En résumé, l'évolution annuelle du guêpier chez *Polistes* provient, en ːrnière analyse, de l'incapacité des guêpes *actives* vieillissantes à nourrir ɔnvenablement le couvain et ce d'une manière qualitative. Le non-renou- ːllement, au cours de la saison, en élements jeunes actifs (ouvrières) dû à apparition des guêpes-filles en diapause (femelles fondatrices-filles) con- ımne le couvain à l'avortement. Un deuxième phénomène interviendrait ors, éventuellement secondaire: l'action pathogène des microorganismes, ovoquant la pourriture des larves. Cette „loque" par des stimuli chimiques ːffluves odorantes?) sur les imago actifs, déclenche la destruction du cou- ıin („massacre du couvain") et provoque la dissolution de la société.

* Certes, dans ces cas, il peut s'agir d'une maladie dûe à un agent pathogène. La rapporter au phénomène du couvain abortif ne serait plus alors justifié.

ZUR BIOLOGIE UND HISTOLOGIE PARASITÄR DEGENERIERTER AMEISENARTEN MIT BESONDERER BERÜCKSICHTIGUNG VON TELEUTOMYRMEX SCHNEIDERI KUTTER (TRIBUS TETRAMORINI)

von

KARL GÖSZWALD
Würzburg, Deutschland

Die Lebensweise der parasitär degenerierten Ameisen, welche selbst unfähig zu einem eigenen Staatenleben, bei Wirtsameisen schmarotzen, verdient besondere Beachtung. Lebensform und Körperform stimmen harmonisch überein. Histologische Untersuchungen lassen auch im inneren Bau eindeutige Beziehungen zum mehr oder weniger hochspezialisierten Parasitismus erkennen. Als Beispiel soll auf *Teleutomyrmex schneideri* Kutter Bezug genommen werden. Zunächst einiges zur Lebensweise dieser, wie der Name sagt, am Ende der Entwicklung stehenden Ameise nach KUTTER, der diese ausserordentlich interessante Art bei Saas Fee, etwa 2200 m hoch in der Schweiz entdeckt hat sowie nach Beobachtungen von STUMPER.

Die *arbeiterlose Tel.* schmarotzt bei der Rasenameise *Tetramorium caespitum* L. In der gemischten Kolonie können vorhanden sein: alte, physogastre *Tel.*-Weibchen, die *Tetramorium*-Königin, sowie zahlreiche Arbeiterinnen dieser Art. Im Juni–Juli gelangen von *Tel.* einige Männchen und viele Weibchen zur Reife, mehrere *Tetr.*-Männchen und -Weibchen, dazu werden viele *Tetr.*-Arbeiterinnen aufgezogen. Die *Tel.*-Weibchen, sowohl physogastre wie stenogastre *Tel.*-Weibchen können sich auf den Wirtsameisen, sogar auf deren Königin wie Ektoparasiten tragen lassen.

Die *unselbständige Lebensweise* hat vor allem eine *Reduktion der Mundteile* zur Folge, welche sich äusserlich z.B. an der Verkürzung der Palpi maxillaris und labiales bis auf zwei Glieder kund tut. Auch bei *Anergates atratulus* Schenk, einer ebenfalls bei *Tetr. caesp.* parasitierenden arbeiterlosen Myrmicine, die von meinem Schüler MEYER untersucht wurde, ergaben sich ähnliche Reduktionserscheinungen. Im Zusammenhang mit der Degeneration der Mundteile steht eine Rückbildung der zugehörigen Muskeln, sowohl bei *Tel.* wie bei *Anerg.*

Bei *Tel.* sind zwar noch sämtliche Muskelelemente nachweisbar, aber sie sind mit Ausnahme der gut entwickelten Mandibelmuskeln sehr schwach. Von der Eigenmuskulatur des Kopfes fehlt beim *Anerg.* Weibchen der Protraktor und Retraktor der Mundhöhle, bei *Tel.* sind beide Muskeln zurückgebildet. Die Pharynxmuskulatur ist bei beiden Arten funktionsfähig, immerhin sind nur zwei dorsale Dilatatoren vorhanden an Stelle der 3 bei *Tetr.* Die Ringmuskulatur und der innere Dilatator des Pharynx sind gut ausgebildet.

Bemerkenswert ist ferner die Ausbildung der mit der Nahrungsaufnahme in Beziehung stehenden Drüsen. Die paarigen Mandibulardrüsen sind in gleicher Weise wie die Muskulatur sowohl bei *Tel.* wie bei *Anerg.* gut ent-

wickelt; bei *Tel.* sind die Zellen sogar rel. gross. Die Pharyngealdrüsen erscheinen bei *Anerg.* im Vergleich zu *Tetr.* normal, bei *Tel.* sind sie zurückgebildet, die Drüsenwände sind allerdings rel. dick. Die bei *Tetr.* vorhandene Maxillardrüse fehlt bei *Tel.* und *Anerg.* Besonders auffallend ist die Reduktion der Labialdrüse; diese mündet nicht, wie bei anderen Hymenopteren, zwischen Hypopharynx und Labium, sie ist bei *Tel.* zu einem kleinen, unpaaren Läppchen zurückgebildet, das dorsal im Prothorax liegend, als kleines Anhängsel des Oesophagus erscheint und in diesen hier unmittelbar einmündet. Bei *Anerg.* besitzt die im Prothorax liegende Labialdrüse gar keinen deutlichen Ausführgang mehr, die Drüsenzellen liegen manchmal sogar zerstreut oder können ganz fehlen. Die dargelegte Rückbildung gewisser Mundteile sowie der sie versorgenden Muskeln und Drüsen dürfte mit der Fütterung dieser Parasiten durch die Wirtsameisen in Zusammenhang stehen. Von den innersekretorischen Drüsen seien die Corpora allata erwähnt, die verglichen mit ihrer Ausbildung bei anderen Ameisen, normal erscheinen.

Von den Lichtsinnesorganen sind die Komplexaugen des *Tel.*-Weibchens rel. klein; dieser Rückbildung entsprechen sehr kleine Lobi-optici. Die Ozellen sind gut ausgebildet. Fast das ganze Oberschlundganglion degeneriert, besonders die Corpora pedunculata, der Centralkörper fehlt, dagegen ist der auch den Parasiten nicht entbehrliche Riechlappen gut gebaut. Ausführlich wird über das Gehirn von *Tel.* Kollege BRUN aus Zürich berichten. Bei *Anerg.* sind ebenfalls sehr starke und zwar mit zum Teil indivuduell verschiedene Rückbildungen festzustellen. Vom übrigen Zentralnervensystem liegen Ganglion 1 und 2 im Pro- und Mesothorax, Ganglion 3, 4, 5 im übrigen Teil des Thorax, 6 im Petiolus. Als *Besonderheit* liegt *Ganglion* 7 bei *Tel.* nicht im 1. Gastersegment wie bei anderen Ameisen und auch bei *Anerg.*, sondern im Postpetiolus, manchmal an der Grenze zum Gaster. So führt *Tel.* auch hinsichtlich des Vorrückens abdominaler Ganglien nach vorne seinen auf einen Endpunkt der Entwicklung hinweisenden Namen mit Recht. Im Gaster selbst sind die bei anderen Myrmicinen getrennt folgenden Ganglien 8, 9, 10 untereinander, sowie mit den ebenfalls einen Komplex bildenden Ganglien 11 mit 13 verschmolzen.

Die Flugmuskulatur ist im weiblichen Geschlecht sowohl bei *Tel.* wie bei *Anerg.* kräftig entwickelt; ich konnte *Tel.*-Weibchen vom Nest weg steil in die Luft auffliegen sehen. Auch ein starkes Endoskelett kann als Kriterium für ein gutes Flugvermögen dienen. Bei dem flügellosen *Anerg.*-Männchen sind in Larven zwar Imaginalscheiben nachweisbar, aber die Flugmuskulatur wird nicht mehr angelegt; nur gelegentlich finden sich einige isolierte funktionslose Muskelfasern zwischen den Fettzellen im Thorax des *Anerg.*-Männchens, und zwar ohne Origo und Insertio.

Gewisse Parasiten verfügen, wie z.B. *Lasius umbratus mixtus,* über einen besonderen Parasitenduft (GÖSSWALD 1938), manche werden besonders intensiv beleckt, wie das *Formica rufa rufa*-Weibchen, nicht aber *F. rufopratensis minor,* welche ihre Kolonie nicht bei fremden Wirtsameisen gründet (GÖSZWALD 1951). Hohle Pinselhaare finden sich bei *Tel.* überwiegend ventralateral

am Thorax nahe beim Petiolus, dazu auf dem Postpetiolus. Solche Pinselhaare stehen in Verbindung mit Drüsen, die aus 6 – 8 Zellen bestehend in die Hypodermis eingelagert sind und ihr Sekret in die hohlen Pinselhaare ergiessen. Dazu finden sich weit zerstreut Poren, von ihnen führen feine Kanälchen durch das Chitin nach innen; diese Poren liegen auffallend dicht dorsal auf Petiolus, Postpetiolus und 1. Abdominalsegment. Man kann vielleicht die Drüsenhaare und Poren als symphile Exsudatorgane deuten. Unverzweigte Haare sind unregelmässig über das ganze Tier zerstreut mit Verdichtung an den Mundwerkzeugen und an der Afteröffnung..

Der *Darmtraktus* ist auch bei parasitischen Ameisen *funktionsfähig.*

Das Gaster ist dorsoventral stark abgeplattet, flach tellerförmig gebaut, oben schwach konkav, unten konvex. Die Organe liegen hier in zweckmässiger Raumausnutzung weitgehend nach der Breite orientiert: Kropf und Mitteldarm sind viel breiter als lang. Die Ovarien sind zu beiden Seiten des Mittel- und Enddarmes gelegen, das Rectum ist von Bursa copulatrix und Receptaculum seminis nach der Seite verdrängt, die malpighischen Gefässe füllen die seitlichen Lücken. Nicht bei allen Individuen ist die Lage der Organe gleich. Der äussere Bau des Gasters weist bereits bei den stenogastren Weibchen auf die Möglichkeit der Physogastrie hin. Die Physogastrie der Eier legenden *Tel.*-Weibchen ist der Ausdruck extremer parasitärer Degeneration. Wie bei *Anerg.* bezweckt die Physogastrie hier einen Ausgleich der besonders schwierigen Arterhaltung durch starke Eiproduktion. Die sehr starken Tergite und die Sternite sind sehr tief teleskopartig ineinandergeschachelt und durch entsprechend lange Intersegmentalhäute miteinander verbunden. Dabei misst das 1. Gastersegment des stenogastren Weibchens über 2/3 des gesamten Gasters. Beim physogastren Weibchen aber haben sich die bisher unscheinbaren restlichen Segmente derart stark ausgedehnt, dass dieser Teil nunmehr weit über die Hälfte ausmacht. Die Höhe des Gasters hat sich verdreifacht. Die zuvor unter zahlreichen Einbuchtungen zusammengelegten Seitenfalten haben sich derart auseinander gezogen. Auffallend mächtig entwickelte ventrale und dorsale Muskelbündel halten dem hohen Binnendruck des Gasters stand. Die Ovarien sind im stenogastren Tier (*Tel.* insgesamt 28, *Anerg.* 24 Ovariolen) so klein wie später ein reifes Ei; im physogastren Weibchen aber sind die Ovariolen sehr reich mit Tracheen versorgt in bester Raumausnützung weit im ganzen Gaster verteilt, von der Ansatzstelle des Gasters am Postpetiolus bis in der Gegend des Afters und auch allseitig bis zur Hypodermis finden sich junge Oozyten, während die reifen Eier vom Mitteldarm ab nach hinten ziehend die Mitte des Gasters einnehmen. Der Enddarm kann von diesen sehr grossen Eiern stark zusammengedrückt sein. Die Fettkörper sind an den äussersten Rand des Gasters verdrängt.

Im Thorax des physogastren Weibchens ist die Flugmuskulatur völlig histolysiert wie auch sonst bei alten Weibchen. Die aus der Muskulatur hervorgegangenen Fettkörper sind hier auffallend gross.

Der *Stachelapparat* ist bei *Tel.* im Gegensatz zu *Anerg.* gut erhalten.

Durch die histologischen Studien gewinnen wir tieferen Einblick in die Lebensfunktionen der parasitischen Ameisen, die sich nach Untersuchungen an mehreren Arten, die vor dem Abschluss stehen, besser deuten lassen werden.

SIMBIOSI E FILOGENESI NEGLI INSETTI

di

C. JUCCI
Pavia, Italia

Non è in pochi minuti che possa trattarsi, sia pure sommariamente, un problema di così vasta portata.

BUCHNER, il grande simbiontologo ho svolto una magistrale relazione precisamente su questo argomento nel simposio della International Union of Biological Sciences dedicato allo studio della simbiosi negli insetti.

Rinuncerò dunque a qualsiasi tentativo di accennare alle linee più generali del problema e mi limiterò a considerare – ed anche questo dovrò farlo sommariamente, quasi schematicamente – un solo caso, quello sul quale io ho direttamente lavorato, il caso della simbiosi nei Blattoidea e negli Isoptera.

Mi sia permesso ricordare come, nel corso dei miei studi sulla differenziazione delle caste nella società delle specie italiane di termiti, io scoprivo, nei reali di complemento e sostituzione, particolari elementi cellulari „adenociti ipodermali"nei quali riconoscevo, a parte l'ipertrofia che presentano in rapporto a condizioni particolari di metabolismo, una disposizione porfologica comune alle altre caste, una duplicazione della struttura del l'ipoderma in corrispondenza agli scleriti, tal quale come nei Blattidi.

La mia attenzione veniva allora focheggiata sui rapporti filogenetici tra questi due ordini di insetti e cominciavo a studiare – su materiale donatomi dal mio Maestro Filippo SILVESTRI alla memoria del quale mi è grata l'occasione di esprimere il mio omaggio reverente – il *Mastotermes darwiniensis,* l'unica specie sopravvissuta, in Australia, di tutta una famiglia estinta che era diffusa durante il terziario in una vasta area includente Europa e Nord-America.

Scoprivo, (1924) nel *Mastotermes* non solo la fauna intestinale di ipermastigini, non ancora segnalata in questa specie, ma ben anche batteriociti nel tessuto adiposo, identici a quelli che tutte le blatte posseggono; e sottolineavo tutto il valore di questa simbiosi ereditaria ereditata nel corso della filogenesi.

Avevo la fortuna di attirare nel 1930 l'attenzione di BUCHNER sull'argomento e pochi anni dopo un eccellente lavoro di KOCK illustrava la trasmissione dei simbionti che dal corpo della madre alle uova avviene con le stesse modalità che nei Blattidi.

Io avevo affermato senz'altro che batteriociti si ritrovano solo nel *Mastotermes.* Pero le termiti da me direttamente studiate erano *Reticulitermes lucifugus* e *Calotermes flavicollis* e benchè questa seconda specie sia una termite di tipo piuttosto primitivo, non è certo un relitto. Per una specie antichissima come l'*Archotermopsis wroughtoni* dell'Himalaya la presenza

di batteriociti non era probabile, dato che IMMS aveva studiato accuratemente l'anatomia microscopica di questa specie, senza segnalare niente di simile. Tuttavia solo ora mi è riuscito di procurarmi esemplari lo studio dei quali mi permette di affermare l'assenza non solo di batteriociti, ma di qualunque formazione (per esempio batteri diffusi tra le cellule del corpo adiposo) che possa rappresentare un rudimento di una preesistente condizione simbiotica.

Dunque veramente solo in *Mastotermes* sopravvive la simbiosi batterica che evidentemente era già presente nelle forme ancestrali di Protoblattoidi dai quali si sono evoluti – da cinquanta a cento milioni di anni fa – sia blattidi che gli isotteri.

Ma anche per la simbiosi con i flagellati poli ed ipermastigini può dirsi lo stesso: la simbiosi doveva essersi già stabilita nei pregenitori comuni, giacchè in forme di blattidi primitivi come il *Cryptocercus* si trova una fauna intestinale così multiforme e complessa che attesta una lunga evoluzione.

Vero è che il *Cryptocercus* rimane per ora almeno isolato anche tra i blattidi xilofagi.

Non avrei assolutamente tempo di accennare ai problemi della evoluzione della fauna intestinale degli isotteri. D'altra parte questo tema è stato ampiamente trattato da HOLLANDE.

Desidero invece discutere brevemente i possibili rapporti, nella filogenesi tra le due forme di simbiosi, quella con i batteri e quella con i protozoi.

Gli Isotteri hanno ereditato dai Protoblattoidi la simbiosi a batteriociti: ma se ne sono svincolati presto, onde non ne è restata traccia che nei Mastotermitidae.

Tra parentesi, generalmente oggi i Mastotermitidae vengono considerati una famiglia dell'ordine, tal quale come i Calotermitidae, Hodotermitidae, Rhinotermitidae e Termitidae. Io mi domando se non converrebbe attribuire ai Mastotermitidae il valore di un sottordine, contrapposto a tutti gli altri isotteri riuniti nel sottordine dei Termitidae e distribuiti nelle famiglie summenzionate.

Caratteri di fondamentale importanza come quelli della mancanza della sutura basale delle ali e della presenza di lobo anale nelle ali posteriori – per non parlare di tanti altri come la presenza di una ooteca analoga a quella della blatte – incoraggiano questa distinzione dei Mastotermitidae da tutti gli altri isotteri..

Ora perchè e come – se è lecito porsi la domanda in questa forma un pò ingenuamente schematica – gli Isotteri hanno abbandonato la simbiosi con i batteri? Probabilmente si sono potuti permettere questo solo quando la simbiosi con i protozoi è divenuta così stabilmente assicurata che l'abbandono della simbiosi con i batteri non rappresentava più un pericolo. Ma dicendo così noi implicitamente ammettiamo che la natura dei rapporti simbiotici sia analoga, che i bisogni dell'insetto cui le due simbiosi provvedono siano corrispondenti.

Ora noi non sappiamo niente di concreto su questi rapporti. Abbiamo soltanto ragione di sospettare che i batteri dei batteriociti aiutino la utilizzazione, come sorgente di azoto, dei prodotti urici accumulati nel corpo adi-

poso e siano legati perciò essenzialmente al metabolismo dell'azoto. [1]

Parrebbe quindi che ci fosse scarso rapporto tra il significato fisiologico delle due simbiosi. Però è da riflettere che la simbiosi con i protozoi non è soltanto importante come sorgente di carboidrati, ma ben anche come sorgente di azoto. Finchè le termiti sono restate fedeli all'alimento legnoso esse hanno avuto bisogno dei simbionti non solo per la digestione della cellulosa, ma anche per una rigorosa utilizzazione delle scarse sorgenti di azoto.

Forse in un primo tempo è stata assai utile la coesistenza delle due simbiosi: quella con i batteri del corpo adiposo faceva sì che l'azoto catabolico potesse tornare a disposizione dell'organismo, quella con i batteri intestinali e con i flagellati utilizzava nel modo più completo l'azoto mobilizzato dai prodotti urici e lo presentava alle termiti in forma proteica.

Poi, con una maggiore ricchezza di fonti di azoto, una economia così rigida come quella legata alla utilizzazione dei prodotti urici non è stata più necessaria. Allora la simbiosi con i batteri poteva essere abbandonata, mentre la simbiosi con i protozoi restava preziosa per la digestione della cellulosa, digestione del resto la quale apre la strada alla utilizzazione del contenuto anche proteico degli elementi cellulari.

Il non essere più indispensabile la riutilizzazione dei prodotti urici può considerarsi derivato, oltre che da una dieta meno povera come sorgente di azoto, anche da un perfezionamento degli adattamenti tra flagellati e termite nel senso che diventava sempre più ragguardevole la proporzione di sostanze proteiche fornite dai protozoi all'ospite. In questo senso un attento studio comparativo delle numerose variazioni possibili nelle varie specie di termiti riuscirebbe assai istruttivo.

Ma può anche pensarsi all'intervento di fattori endocrinici, nel senso di una evoluzione di quel sistema di ghiandole a secrezione interna (*corpora allata*, ghiandole cefaliche e protoraciche) dalla interazione delle quali è regolato lo sviluppo delle termiti (e in certo qual modo anche la differenziazione delle caste). [2]

D'altra parte che ci sia stata una evoluzione di questi fattori endocrinici nella filogenesi degli isotteri è non soltanto ammissibile a priori, ma anche dimostrato in cento senso dalla diversa profondità che i fenomeni di „ipnosi" legati a certe mute, raggiungono nei diversi generi di termiti, sicchè può dirsi che lo sviluppo non sia ugualmente lontano, in tutti gli isotteri, dalla olometabolia.

Questo per quel che riguarda l'abbandono della simbiosi a batteriociti. Forse è più facile rappresentarsi come le termiti si siano liberate della simbiosi a batteri, che come le blatte siano restate tanto fedeli ad essa: l'attuale loro modo di vita e alimentazione, non particolarmente povera di azoto, non ci lascia facilmente immaginare il perchè, ma bisognerebbe conoscere quali erano le abitudini delle forme ancestrali.

1) come TOTH ha riaffermato nelle sue relazioni al simposio sulla simbiosi.

2) Osservazioni come quella comunicata al congresso da BODENSTEIN sugli effetti della asportazione del corpo cardiaco in *Periplaneta* possono darci una idea della importanza di questi fattori endocrinici.

Bisogna anche riflettere che dev'essere più facile nel corso della filogenesi l'abbandono di una simbiosi come quella delle termiti con i flagellati (in questo caso bastano lievi alterazioni nei dispositivi che assicurano la reinfestazione) anzichè l'abbandono di una simbiosi come quella con i batteri dato che in questo caso si è evoluto un meccanismo di trasmissione dal corpo della madre all'uovo che sembra più difficilmente mutabile.

Del resto non abbiamo neanche lontanamente la pretesa di spiegarci perchè gli isotteri hanno presentato una così lussureggiante evoluzione, mentre i blattidi si presentano, anche dal punto di vista morfologico, tanto conservatori.

E' tutto un vantaggio della vita sociale?

Quanto poi all'abbandono della simbiosi con i flagellati nelle termiti superiori questo potrebbe considerarsi legato all'abbandono della alimentazione legnosa, visto che nelle stesse termiti nelle caste e stadi nei quali l'alimento legnoso viene a mancare, automaticamente consegue la scomparsa della fauna ipermastigina.

Ma, anzitutto, la cellulosa resta anche per le termiti superiori una sorgente assai importante, forse prevalente, di sostanze nutritive.

E poi: è il non nutrirsi più di legno che ha fatto scomparire i protozoi, o piuttosto è il deterioramento dei rapporti simbiotici con i protozoi che ha indotto all'abbandono della alimentazione legnosa?

Ma che cosa potrebbe aver portato a questo deterioramento?

Potrebbe pensarsi ad un cangiamento dei rapporti di trofallassi tra gli individui della colonia che abbia indotto una precarietà nelle possibilità, prima così bene assicurate, di reintestazione dopo le mute. Questa rivoluzione dei rapporti di trofallassi potrebbe a sua volta essere stata indotta da un cangiamento nei processi di differenziazione delle caste prima effettuate, nelle termiti inferiori, mediante mezzi estrinseci come la dieta alimentare (almeno per certe caste) e poi nelle termiti superiori avviatasi ad un meccanismo endogeno, mendeliano.

Naturalmente varie altre spiegazioni sono possibili. Per esempio l'acquisizione di enzimi cellulositici da parte della termite. Questa acquisizione, permettendo alla termite di digerire la cellulosa senza necessità dello intermediario rappresentato dai protozoi, avrebbe abbastanza rapidamente allentato i vincoli della simbiosi. Finchè la termite ha assoluto bisogno dei protozoi per digerire la cellulosa, qualunque mutazione nel senso di allentare i vincoli della coaptazione genetica tra i due ospiti viene scartata sotto la spinta della pressione di selezione. Ma una volta comparse capacità cellulolitiche la pressione di selezione sarebbe assai allentata e di conseguenza si allenterebbero progressivamente i vincoli della coaptazione genetica.

Queste considerazioni, necessariamente ipotetiche, hanno spratutto il valore e lo scopo di rendere più evidente che, per approfondire le nostre conoscenze sulla evoluzione della simbiosi nelle termiti, è assolutamente necessario uno studio largamente comparato: morfologico, fisiologico, biologico (etologico, ecologico, corologico).

Bisogna cioè prendere in considerazione attenta la evoluzione dei costumi sociali la quale, se è regolata dalle possibilità organiche inerenti al livello di evoluzione morfologica e fisiologica raggiunto dell'organismo, a sua volta concorre attivamente a determinare la direzione di un ulteriore progresso. (vedi ad esempio l'evoluzione delle vescicole seminali negli Isotteri).

Bisogna considerare altresì le caratteristiche fisiche dell'ambiente – climatiche, pedologiche ecc. – e la distribuzione geografica. Per es. la vita nei paesi tropicali potrebbe forse avere, anche soltanto per il fatto della temperatura troppo elevata, scoraggiato la simbiosi con i flagellati: lo shoc termico difatti risulta uno dei più efficaci meccanismi di defaunazione sperimentale.

CONTRIBUTION À L'ÉTUDE ÉCOLOGIQUE DES PARASITES ET COMMENSAUX DE COLÉOPTÈRES (2e Note)

par
JEAN THÉODORIDÈS
Paris, France

Le grand développement pris récemment par l'Ecologie et la Biocénotique a permis l'étude très complète du peuplement de divers milieux terrestres ou aquatiques. Les organismes vivants constituent également un milieu qu héberge des biocénoses de parasites et commensaux (parasitocénoses au sens de PAVLOVSKY).

Nous avons entrepris ces dernières années l'étude du peuplement associ à certains Celéoptères; ces recherches ont été effectuées essentiellemen dans le département des Pyrénées-Orientales (France) et d'après du matérie méditerranéen (Corse, Baléares, Italie) ou africain (Maroc, Mauritanie, Mada gascar) envoyé par divers correspondants.

Une note antérieure (THÉODORIDÈS 1951b) donnait nos premiers résultat

Hôtes

Nous nous sommes limités à l'étude de certaines familles et de certains genres caractéristiques quant à leur éthologie et écologie: essentiellement des Scarabéides, Ténébrionides, Chrysomélides, et accessoirement quelques Carabiques, Staphylinides, Silphides et Dermestides. Les principaux genres étudiés figurent dans le tableau ci-joint.

Parasites et commensaux

Les Coléoptères hébergent des organismes appartenant aux groupes les plus divers dont les principaux sont:

Bactéries, Champignons (Entomophtorales, Hypocréales, Beauvériacées* Laboulbéniales*), Trichomycètes (Eccrinales*), Schizomycètes (Spirochètes

Protozoaires (Rhizopodes, Flagellés, Ciliés, Sporozoaires: Grégarines* e Coccidies*).

Helminthes (Cestodes: formes larvaires ou cysticercoïdes*, Nématodes: Mermithidés, Anguillulidés*, Oxyuridés*, Spiruridés larvaires*, Gordiacés Acanthocéphales: larves).

Arthropodes (Acariens: Gamasiformes*, Thrombidiformes*, Sarcoptiformes Pseudoscorpions phorétiques, Insectes entomophiles et entomophages: prin cipalement Diptères* et Hyménoptères*.

Seuls les groupes indiqués par une astérisque ont été recherchés ou ren contrés, l'étude de l'ensemble des Bactéries ou même des Protistes de Co léoptères constituant à eux seuls des sujets spéciaux d'étude.

Le tableau ci-joint résume la distribution des parasites et des commensau suivant les genres des hôtes, d'après ce que nous avons observé jusqu' présent.

On peut y remarquer que:

I. Les Grégarines Polycystidées se rencontrent chez presque tous les Coléoptères, cet ordre renfermant d'ailleurs la majorité de leurs hôtes connus (180 espèces d'après une récente estimation de STEINHAUS, chiffre de toute évidence bien inférieur à la réalité). Plusieurs espèces nouvelles ont été décrites en collaboration avec le Professeur Odette TUZET; ce sont:

Actinocephalidae

1. Pyxinia foliacea (Tuzet et Théodoridès 1951a) chez *Dermestes frischi* Kug.
2. Actinocephalus licini (Tuzet et Théodoridès 1951b) chez *Licinus punctatulus* Fab.

Acanthosporidae

3. Cometoïdes licini (Tuzet et Théodoridès ibid.) chez le même hôte.

Gregarinidae

4. Sphaerocystis tentyriae (Tuzet et Théodoridès 1951c) chez *Tentyria mucronata* Serv.
5. Hirmocystis inaequalis (Tuzet et Théodoridès 1951c) chez *Asida sericea* Ol.

Stylocephalidae

6. Stylocephalus variabilis (Tuzet et Théodoridès ibid.) chez le même hôte et *Tentyria mucronata* Serv.
7. Sphaerorhynchus hamoni (Tuzet et Théodoridès ibid.) chez *Akis punctata* Thunb.
8. Sphaerorhyncus chabaudi (Tuzet et Théodoridès ibid.) chez *Akis elegans* Sol.
9. Cystocephalus algerianus A. Schneider var. mauritanicus (Tuzet et Théodoridès ibid.) chez *Pimelia angulata* F. ssp. *angulosa* Ol.

II. Les Coccidies coelomiques (Adelea) n'ont été jusqu'ici trouvées que chez des Ténébrionides (*Asida, Akis, Phylan*).

III. Les Nématodes offrent un important contingent d'espèces associées à des Coléoptères et appartenant à différents groupes:

1. Les Anguillulata trouvés sont des Anguillulidae et Diplogasteridae coprophages et nécrophages vivant à l'état larvaire dans le segment génital des Geotrupini ou des Silphini (THÉODORIDÈS 1949, 1951a); une espèce: Diplogaster aphodii Bovien est parasite de la cavité générale des *Aphodius*.

   Parmi les Anguillulata récoltés, 6 espèces sont nouvelles pour la France et d'autres suivront sûrement.
2. Les Oxyurata sont localisés dans l'intestin postérieur des larves de Scarabaeoidea saprophages (*Anoxia, Anomala, Oryctes, Potosia*).
3. Les larves encapsulées de Spirurata se rencontrent dans la cavité générale de divers Scarabéides coprophages et Ténébrionides.

IV. Des cysticercoïdes de Cestode Cyclophyllidé ont été trouvés chez des Ténébrionides (*Tentyria, Phylan*).

V. Les Acariens de Coléoptères appartiennent à plusieurs des catégories biologiques définies par TRÄGARDH:

1. Formes ectoparasites temporaires *(Erythraeus)*.
2. Formes paraphages (Canestriniidae); Mr. J. COOREMAN (Bruxelles) a examiné nos récoltes de cette famille et a déjà pu y reconnaître un genre nouveau *(Paramansia)* et plusieurs espèces insuffisamment décrites (COOREMAN 1950).
3. Formes phorétiques facultatives, sessiles (Uropodes), ou ambulatoires (Gamasiformes divers).

Un important matériel d'Acariens récoltés sur Coléoptères est actuellement à l'étude par divers spécialistes.

VI. Les Insectes entomophages sont dans l'ensemble assez rares dans notre matériel; cependant, chez certains Carabiques vivant dans les détritus du littoral *(Ophonus, Harpalus)*, l'infestation par des larves de Diptères semble assez constante.

VII. Nous avons également récolté quelques Champignons entomophytes (Laboulbéniales sur des *Ceuthosphodrus* guanobies, Beauveria sur *Chrysolina)* et des Eccrinales chez des Scarabéides *(Aphodius* adulte, *Potosia* larvaire).

Remarques biologiques et écologiques

La parasitofaune associée aux Coléoptères permet diverses remarques d'ordre biologique et écologique:

I. Modalités de l'association

Il est parfois très difficile de préciser la nature exacte des rapports entre les organismes associés et l'hôte; on peut cependant distinguer par degré croissant de spécialisation dans l'association:

1. Des phorétiques et paraphages (Gamasiformes, Canestriniens).
2. Des inquilins (Anguillulides du segment génital).
3. Des ectoparasites temporaires *(Erythraeus)*.
4. Des endoparasites (Grégarines, Coccidies, Oxyurides, Spirurides, certains Anguillulides, cysticercoïdes, Insectes entomophages).

Parmi ces derniers, certains sont bien tolérés et peuvent être rangés dans la catégorie des *parasites inoffensifs* [1)] (Grégarines, Oxyurides); il en est de même des stades quiescents d'Helminthes (larves de Spirurides et cysticercoïdes) qui pourraient presque être rangés parmi les inquilins.

Au contraire, les Coccidies coelomiques, certains Diplogaster parasites de la cavité générale et les larves d'Insectes entomophages peuvent causer des lésions ou la mort de l'hôte.

II. Localisation des parasites et commensaux chez l'hôte

Les différentes parties du corps des Coléoptères hébergeant des organismes sont les suivantes:

1) Surface externe du corps, appendices et articulations (Gamasiformes, Uropodes, Laboulbéniales).
2) Espace sous-élytral (Canestriniens, Caloglyphides, Gamasiformes, certains Anguillulides).

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1) „Il est très difficile de caractériser le parasite en introduisant la notion de nocivité dans sa définition. En effet, certains parasites sont *totalement inoffensifs*, parfois même utiles" (BRUMPT, Précis de Parasitologie 1949: 6).

3) Segment génital (Anguillulides).
4) Cavité générale (Coccidies, larves de Spirurides et cysticercoïdes, larves d'Insectes entomophages).
5) Intestin: moyen: Grégarines, Polycystidées.
postérieur: Oxyurides, Eccrinales.

Chacun de ces biotopes restreints héberge pour ainsi dire une petite biocénose ou *synusie.*

II. Facteurs de l'infestation des hôtes

L'infestation des Coléoptères dépend de plusieurs facteurs:

1. Facteurs „phylogéniques"

Certaines associations paraissent très anciennes et leur génèse s'explique difficilement par l'éthologie ou l'écologie des hôtes; l'exemple le plus frappant est celui des Grégarines Polycystidées se rencontrant dans presque toutes les familles de Coléoptères qu'ils soient carnivores, nécrophages, coprophages, saprophages ou phytophages.

2. Facteurs écologiques

Certaines infestations par d'autres parasites et commensaux s'expliquent au contraire par l'éthologie et l'écologie de ceux-ci et de leurs hôtes:

a) les espèces coprophages et nécrophages servent presque constamment de véhicule aux stades jeunes d'Acariens qui adultes vivent dans les excréments ou les cadavres; les Anguillulides du segment génital des Geotrupini et Silphini sont de même les stades larvaires d'espèces coprophages ou nécrophages.

) les futurs Spirurides larvaires et cysticercoïdes sont ingérés par les Coléoptères coprophages, nécrophages ou saprophages qui s'infestent sur les excréments ou les cadavres de l'hôte définitif.

) les Oxyurides parasites de certains Scarabéides larvaires vivant dans la terre humide ou le terreau ne se trouvent que chez ces hôtes, on peut donc penser que l'infestation de ceux-ci est liée à leur écologie. D'autre part, chez les Dynastidae et Cetonidae, l'intestin postérieur comporte une panse rectale où s'accomplissent des fermentations bactériennes, ce qui constituerait un milieu biologique favorable sinon indispensable au développement des Oxyurides.

) les Insectes entomophages n'ont jamais été trouvés (à quelques rares exceptions près citées dans la littérature) chez les Coléoptères coprophages, les adultes des parasites entomophages étant en général floricoles.

) les parasites de Chrysomélides (cf. JOLIVET 1950, JOLIVET & THÉODORIDÈS 1951) comprennent de nombreux Insectes entomophages ce que l'on était en droit d'attendre chez des Coléoptères floricoles ou phytophages; au contraire, les Oxyurides, Spirurides, cysticercoïdes dont les oeufs sont ingérés avec des excréments n'ont jamais été trouvés chez eux.

Conclusions

Nos recherches en cours sur les parasites et commensaux de Coléoptères permettent de metrre en évidence:

1. De nombreuses espèces nouvelles dans les différents groupes d'organismes recherchés; ce fait n'a rien d'étonnant vu le peu d'intérêt généralement accordé à ceux-ci;
2. Divers degrés d'association allant de la simple phorésie à l'endoparasitisme;
3. L'existence d'une parasitofaune de composition globale définie, variable qualitativement selon les groupes d'hôtes envisagés.

En outre, il paraît surtout utile d'insister sur le fait que l'infestation des Coléoptères hôtes dépend dans une très large mesure de leur écologie et de leur éthologie.

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DISCUSSION

Mr. **Couturier:** Avez-vous trouvé des Mermithidae dans les Coléoptères récoltés à Banyuls?

Mr. **Théodoridès:** Malheureusement non, ceci était peut-être dû à l'aridité des biotopes où mes recherches ont été effectuées. Un correspondant de Barcelone (Dr. BALCELLS) m'a envoyé des *Hexamermis* sp. trouvés aux environs de cette ville chez *Chrysomela populi* et *Agelastica alni.*

Mr. **Cooreman:** L'aspect quantitatif a-t-il retenu votre attention en ce qui concerne les récoltes d'Acariens Canestriniides? Ce point étant de nature à orienter les recherches sur la biologie de ces Acariens.

Mr. **Théodoridès:** Des comptages de Canestriniides ont été effectués particulièrement en ce qui concerne *Pseudamansia chrysomelinus* C.L.Koch, vivant sous les élytres de diverses espèces de *Timarcha.* Le nombre d'exemplaires varie entre 2 ou 3 et 50 ou plus. L'infestation est particulièrement élevée en automne.

Coléoptères classés par genres + = infestés o = non recherchées ? = douteux	Fungi			Protozoa		Vermes Nematoda				Acari			Insecta	
	Eccrinales	Laboulbéniales	Beauveriaceae	Gregarina Polycystidea	Coccidia	Anguillulata	Oxyurata	Spirurata	Cestoda (cysticercoïdes)	Gamasiformes	Thrombidiformes	Sarcoptiformes	Diptera Tachinidae	Hymenoptera Braconidae
Carabidae														
Carabus				+						+		+		
Licinus				+										
Ophonus				+									+	
Harpalus													+	
Ceuthosphodrus		+		+						+				
Staphylinidae														
Ocypus				+										
Silphidae														
Necrophorus				o		+				+				
Silpha				+		+								
Lucanidae														
Dorcus				+		+				+		+		
Scarabaeidae														
Trox				+				+						
Scarabaeus				+		+		+		+		+		
Sisyphus						+		+						
Copris				+						+				
Bubas						+		+		+				
Geotrupes				+		+		+	?	+		+		
Aphodius	+			o		+				+				
Anoxia				+			+					+		
Anomala				+			+			+				
Oryctes				+			+			+				
Potosia	+			+			+							
Dermestidae														
Dermestes				+										
Tenebrionidae														
Tentyria				+				+	+					
Asida				+	+								+	
Akis				+	+					+		+		
Scaurus										+				
Pimelia				+				+						
Blaps				+								+		
Phylan				+	+				+		+		+	+
Opatrum				+										
Chrysomelidae														
Timarcha				+							+	+	+	
Chrysolina			+	+								+		+
Galeruca				+							+			

Répartition des parasites et commensaux de Coléoptères suivant
les différents genres considérés

L'INFLUENCE DE L'HUMIDITE SUR L'INCUBATION DES OEUFS DE LA MOUCHE DES FRUITS (Ceratitis capitata WIED.) (Diptera, Trypetidae)

par
KYRIACOS SACANTANIS
Paris, France

Introduction

L'influence des différents facteurs du milieu sur l'incubation des oeufs de *Ceratitis capitata* WIED., bien que très étudiée par le passé, présente encore un certain nombre d'inconnues, parmi lesquelles il convient de citer en tout premier lieu, la Lumière, la Pression atmosphérique et même l'Humidité.

La mortalité embryonnaire peut varier, suivant les fruits utilisés pour provoquer la ponte de la femelle *C.c.*, et cette variabilité a été généralement expliquée par l'intervention de facteurs chimiques et mécaniques.

C'est ainsi que, dans le cas de pontes sur Orange, QUAYLE (1), BACK & PEMPERTON (2), attribuent la non-éclosion des oeufs, soit à l'action nocive des huiles essentielles et du tanin, soit à d'autres sécrétions de l'épicarpe qui imperméabilisent la cavité de la ponte. Par contre, KECK (3), GRÜNBERG (4) et autres, expliquent la forte mortalité des oeufs, par la dureté et l'épaisseur de l'épicarpe de l'Orange.

En fait, l'influence de l'humidité, a été, le plus souvent, ignorée. RIVNAY (5) cependant, note qu'il est possible que ce dernier facteur intervienne pour une certaine part dans la régulation des éclosions.

Un ensemble d'expériences nous ont permis d'établir, avec suffisamment de précision, les relations qui peuvent exister entre la teneur en eau du milieu ambiant et le pourcentage des éclosions observées.

2. *Etude préliminaire*

Des oeufs provenant d'une ponte effectuée depuis au plus 4 heures par *C.c.*, sur une poire, sont répartis entre deux verres de montres dont l'un seulement contient de l'eau. Ils sont ensuite introduits dans une chambre climatisée: 26° C. $\pm$ ½° C. et 60–70% d'humidité relative. Tandis que les oeufs placés à sec dans l'un des verres de montre se desséchent en l'espace de 4 à 5 heures, ceux qui se trouvent dans l'eau arrivent tous à éclosion, après 30 à 48 heures d'incubation. Dans ce dernier cas, les jeunes larves continuent à vivre environ une semaine.

3. *Méthode utilisée*

L'absence d'observations suffisantes concernant l'influence de l'humidité sur l'incubation des oeufs de *C.c.* peut être attribuée, semble-t-il, aux difficultés techniques rencontrées notamment, dans la réalisation de milieux à Humidité relative déterminée et stable. Ce problème, d'intérêt général, a oc-

cupé de nombreux chercheurs et deux méthodes principales ont été mises au point. La première consiste en l'utilisation des solutions sursaturées des sels minéraux: elle a été proposée par l'entomologiste américain TH. J. HEADLEE (6), puis développée, contrôlée et commentée par plusieurs chercheurs.

La seconde méthode, qui consiste dans l'emploi d'acide sulfurique à différentes concentrations, a été indiquée par WILSON (7) et utilisée entre autres par PARKER (8). Il semble cependant qu'elle doive être abandonnée à cause des effets souvent toxiques des vapeurs sulfuriques sur les organismes vivants en expérience. La présente étude est faite sur la base de la méthode des solutions sursaturées de sels minéraux, placées dans des récipients en verre d'un litre, à fermeture pratiquement étanche. Les récipients sont remplis jusqu'au tiers. Les sels suivants ont été utilisés:

TABLEAU 1

1 Nitrate d'Ammonium	NH_4NO_3	H.R. ± 68%	
2 Chlorure de sodium	ClNa	H.R. ± 75%	(9,10)
3 Chlorure d'Ammonium	NH_4Cl	H.R. ± 79%	(9,10)
4 Chlorure de Potassium	KCl	H.R. ± 85%	(9,10)
5 Nitrate de Potassium	KNO_3	H.R. ± 95%	(9,10)
6 Eau distillée	H_2O	H.R. ± 98%	
7 Placement des oeufs dans l'eau distillée			

Le contrôle du degré hygrométrique de l'espace clos est effectué dans deux récipients témoins, à l'aide de l'hygromètre du type Edney. A la suite de l'expérimentation minutieuse de HAMILTON (11), (18), une précision de l'ordre de ± 5% peut être admise.

Nous avons par ailleurs opéré une double vérification des hygromètres Edney, au moyen d'un psychromètre Richard avant et après leur utilisation.

Les expériences ont eu lieu dans la chambre climatisée précédemment définie. Les oeufs de *C.c.* recueillis sur une poire 4 heures et 24 heures après la ponte, sont placés très rapidement par groupes de 20 dans des verres de montre secs et introduits dans les récipients à humidité constante.

4. *Résultats*

Le tableau 2 récapitule les résultats obtenus.

(Conditions d'expérience: température 26° C. ± ½° C.; 10 groupes de 20 oeufs dans des verres de montre; récipients d'un litre fermés hermétiquement).

Ce tableau montre que le point critique d'humidité relative pour une incubation normale des oeufs de *C.c.*, se trouve aux environs de 75%.

En effet au-dessous de 75% H.R. aucune éclosion n'est observée, dans les deux cas expérimentaux. De plus la progression des pourcentages d'éclosion est continue lorsque l'hygrométrie croît régulièrement de 75% à 98% H.R. Deux autres constatations peuvent encore être faites:

1) A 75% H.R. l'éclosion des oeufs demeurés seulement 4 heures dans le

TABLEAU 2

Influence de l'Humidité Relative sur l'incubation des oeufs de *Ceratitis capitata* WIED.

% H.R.	Nombre Oeufs	Heures entre la ponte et la prise des Oeufs	Pourcentage moyen d'éclosion	Durée de l'incubation
68	200	4	0	–
	200	24	0	–
75	200	4	2	56 – 60
	200	24	45	48 – 58
79	200	4	70	48 – 56
	200	24	72	40 – 56
85	200	4	81	45 – 50
	200	24	85	40 – 48
95	200	4	84	36 – 48
	200	24	90	32 – 48
98	200	4	83	36 – 48
	200	24	90	32 – 48
ds eau distillée	200	4	95	36 – 48
	200	24	96	30 – 48

fruit, est faible (2%) tandis qu'elle intéresse déjà 45% des oeufs restés 24 heures dans le même fruit. Cette différence doit être attribuée aux phénomènes d'absorption d'eau par les oeufs, dès les premiers stades embryonnaires, phénomènes qui ont été mis en évidence par un certain nombre d'auteurs parmi lesquels CAPPE de BAILLON (12), ROGNWAL (13), COUSIN (14), BEAMENT (15). Il faut encore noter que cette différence s'amenuise au fur et à mesure que la teneur en vapeur d'eau du milieu augmente.

2) L'incubation des oeufs dans l'eau distillée est entièrement régulière et s'achève dans un minimum de temps. Les oeufs sont transparents et permettent de suivre toute l'évolution embryonnaire. La larve nouvellement éclose est également transparente et montre un filament qui s'échappe de l'anus et qui se détache facilement. La nature de ce filament n'a pas été étudiée. La jeune larve peut vivre plongée dans l'eau distillée pendant une semaine.

5. *Conclusions*

Certes, ce milieu d'expérimentation n'a, à première vue, que peu de rapport avec le milieu naturel des fruits sur lesquels a lieu la ponte des oeufs, dans la nature. Des essais comparatifs sur divers fruits ou sur un milieu synthétique nutritif (16) nous ont montré que le pourcentage d'éclosion n'était jamais supérieur aux pourcentages donnés par le tableau 2, et surtout que les pourcentages d'éclosion sont en relation directe avec la teneur en eau des fruits naturels ou artificiels utilisés pour la ponte.

Mais les résultats des expériences précédemment exposées peuvent contribuer à l'explication de la forte mortalité des oeufs de *C.c.* qui est observée sur les oranges et qui a été attribuée à d'autres causes. La teneur en eau de la peau des oranges des variétés à épicarpe épais est faible, notamment en ce qui concerne la quantité d'eau contenue dans les espaces intercellulaires. WEHMER (17) mentionne 70–71% de teneur totale en eau. Des mesures effectuées par nous-mêmes indiquent que les variétés d'oranges à peau épaisse, donnent un maximum de 70 % de teneur totale en eau.

Or, ce chiffre correspond, à peu près, au point critique d'H.R. que nous avons determiné dans nos expériences.

Enfin, indépendamment du point de vue éthologique notre travail permettra d'apporter une contribution à l'étude du métabolisme et du rôle de l'eau au cours du développement embryonnaire.

Résumé

1) Les oeufs de *C.c.* sont extrêmement sensibles à l'action de l'humidité du milieu dans lequel ils se trouvent.

2) Le seuil léthal inférieur d'humidité relative est compris entre 68 et 75%.

3) L'optimum d'H.R. est atteint lorsque l'atmosphère est saturée. Ceci est démontré non seulement par le pourcentage des éclosions observées, mais encore par la durée de l'incubation, qui est la plus réduite au voisinage du point de saturation.

4) L'incubation et l'éclosion régulières des oeufs de *C.c.*, dans l'eau distillée, ainsi que la survivance des jeunes larves dans ce milieu pendant une semaine, peuvent constituer le point de départ de nouvelles recherches.

5) On comprend donc plus facilement la forte mortalité qui est notée chez les oeufs de *C.c.*, pondus dans l'épicarpe à faible teneur en eau de certains fruits, tel l'orange. Cependant il convient de rechercher l'importance de ce facteur, qui doit agir en coopération avec certains composés chimiques, spécifiques de l'épicarpe d'orange.

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DISCUSSION

Mr. Dalmeyer: Did you make any experiments by putting the eggs in a solution of the „huile essentielle" extracted from the skin of the citrus fruits?

Mr. Sacantanis: Non et à notre connaissance ces expériences n'ont pas été faites systématiquement.

Mr. Rivnay: Do not you think that you change the environment of the eggs by taking them out of the oviposition hole? And do you think the environmental humidity can enter the ovipositon hole?

Mr. Sacantanis: Il est certain que les conditions du milieu sont différentes. Mais l'oeuf pour se développer doit emprunter de l'eau à l'environnement. Or, cette eau ne peut, dans l'épicarpe de l'orange, provenir que de l'air contenu dans la cavité de ponte. Nous avons montré que la teneur en eau de l'épicarpe ne dépasse pas 70 à 71%, c'est à dire qu'en première approximation l'atmosphère de la cavité de ponte présente un degré hygrométrique inférieur au point critique que nous avons expérimentalement précisé. Aussi l'air d'environnement de fruit a toujours un degré d'humidité inférieur au point critique.

L'ACTIVITE CINESTHESIQUE DES IMAGOS DE CERTAINS **Agriotes** (Col. Elateridae)

par
Jacques D'AGUILAR
Versailles, France

L'activité de déplacement des adultes d'*Agriotes* a été peu étudiée. Quelques auteurs ont observé cette activité et ont remarqué qu'elle avait surtout lieu la nuit. Nos observations et expériences poursuivies depuis plusieurs années en Bretagne, ont eu pour but d'apporter des précisions sur les facteurs influençant le déplacement des imagos d'*Agriotes* appartenant aux espèces: *obscurus* L.; *lineatus* L. et *sputator* L.

L'activité de déplacement comprend le vol et la marche que nous étudierons séparemment.

Déplacement au vol

Si un certain nombre d'espèces d'Elateridae ont été souvent observés au vol il n'en est pas de même des 3 espèces nuisibles d'*Agriotes*. L.MESNIL (1930) écrit „Nous avons passé de nombreuses années dans une localité fortement envahie sans jamais voir ces Insectes se servir de leurs ailes pas plus dans la journée que le soir ou la nuit". Puis R.LANGENBUCH (1932) et W.SUBKLEW (1934) confirment son point de vue.

Cependant dès 1929 A. I. MASAITIS supposait que *A. sputator* L. volait quelquefois et V.M.POSPELOVA (1939) indique des vols de *A. obscurus* L. dans la région de Tomsk. J.C.F.FRYER (1941) a pris *A.obscurus* volant tard dans la soirée en juin par une humidité élevée et un vent faible. M.COHEN (1942) signale des observations de vol mais note que des pièges de géraniol et d'eugénol placés à 75 cm de hauteur n'avaient pas donné de résultats. Enfin M.V.BRIAN (1947) a observé dans une serre des vols d'*Agriotes obscurus* et *lineatus* et précise qu'il s'agit d'après-midi chaudes et ensoleillées où le vent était absent et l'hygrométrie élevée.

Nous avons fait des remarques assez semblables en Bretagne. Par des journées chaudes et orageuses nous avons observé des vols d'*Agriotes lineatus* et *obscurus*.

L'insecte monte à l'extrémité des feuilles de Graminées, écarte ses élytres et ses ailes et exécute un vol plané qui peut l'amener à plusieurs mètres de son point de départ. La hauteur des vols observés n'excédait pas 30 cm et le vent peut aider ces déplacements. Des pièges constitués par des bottillons de Graminées attractives et situés à 0 m. 50 et 1 mètre de la surface du sol ne donnèrent aucun résultat. Il semble donc que les adultes d'*Agriotes lineatus* et *obscurus* ne volent pas la nuit, mais uniquement pendant les après-midi chaudes et humides et que ce comportement, au moins en Bretagne, soit tout à fait exceptionnel.

Déplacement à la marche

Divers auteurs ont remarqué que les *Agriotes* évitent généralement la lumière et se déplacent principalement le soir et la nuit (M.COHEN 1942). Plus récemment M.V.BRIAN (1947) a expérimenté à l'aide d'un actographe d'un type particulier qui lui permettait de noter automatiquement les montées d'adultes d'*Agriotes obscurus L.* le long d'une tige de fer [1]. Cet appareil lui permit de remarquer que l'activité la plus grande (sur 22 jours du mois de mai) se situait entre 18 h. et 6 h. (G.M.T.) avec un maximum entre 18 h. et 24 h. (G.M.T.). D'après l'examen de certaines données, BRIAN pense que le facteur température doit avoir surtout une action sur l'activité des animaux pendant la nuit et le matin.

Par des piégeages systématiques dans un même champ, en utilisant des bottillons attractifs de Trèfle ou de Graminées (J.d'AGUILAR 1948) nous avons pu mettre en évidence l'importance des déplacements nocturnes. Les relevés étaient faits à 19 h., 23 h. et 6 h. (G.M.T.), les 3 espèces dénombrées et leur sexe examiné. La moyenne horaire du nombre d'individus des 3 espèces (leur proportion étant à peu près équivalente) relevée dans les pièges pendant les périodes indiquées donne des résultats significatifs.

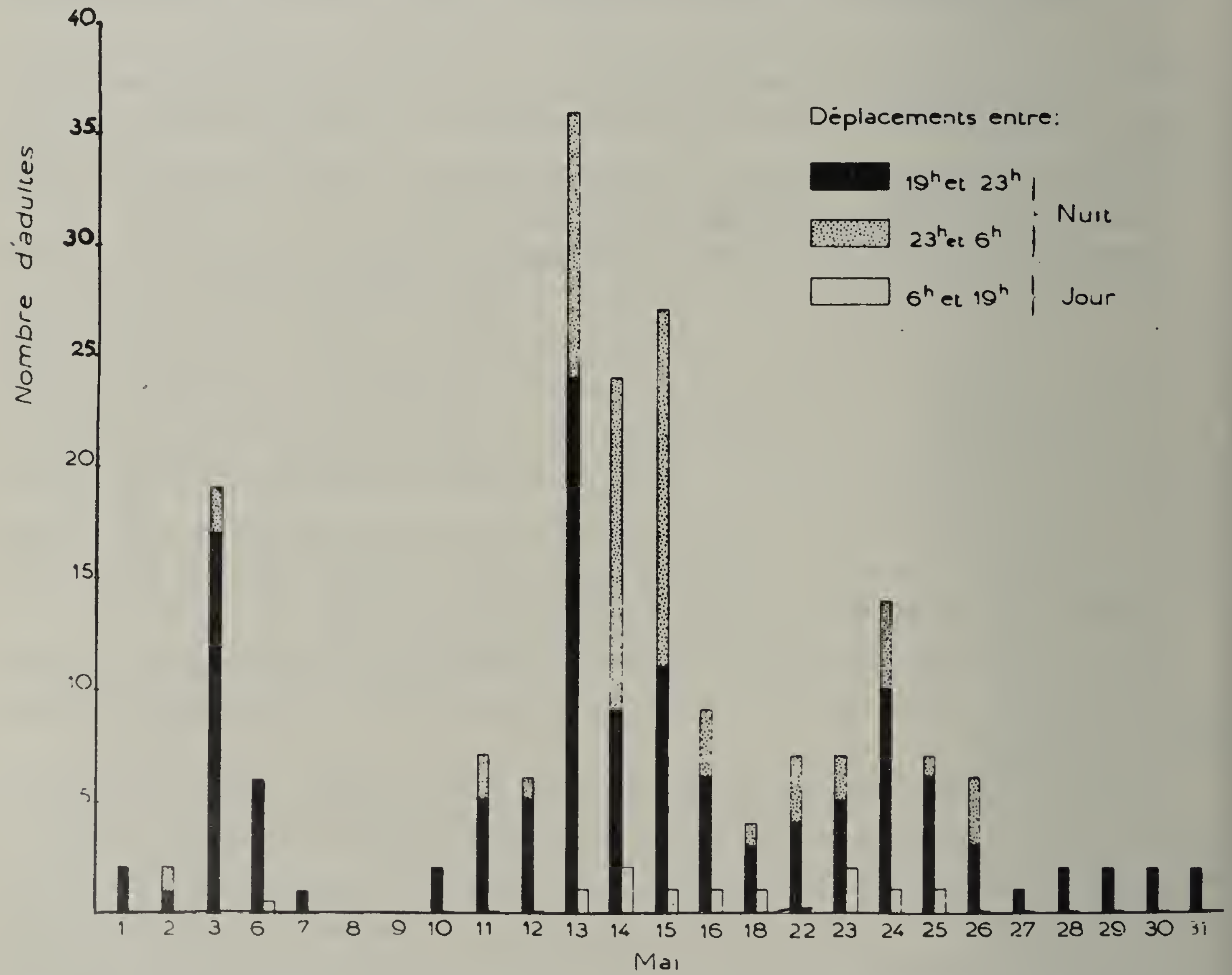


Fig. 1. Captures d'imagos d'*Agriotes* sous des bottillons à différentes heures de la journée.

1) Le principe de cet actographe est basé sur le fait que les adultes quand ils sont actifs, grimpent le long des tiges. Il nous semble que ce fait ne peut rendre compte de l'ensemble de l'activité de déplacement.

Le graphique précédent (Fig. 1) montre nettement l'importance des captures de nuit (19 h. – 6 h.) sur les captures de jour (6 h. – 19 h.) avec une prédominance entre 19 et 23 h.

Nos observations de nuit nous ont permis de confirmer l'activité nocturne des imagos d'*Agriotes*; nous les avons suivis grimpant le long des tiges et des feuilles de diverses plantes, mâchonnant ces dernières et avons remarqué leur comportement était nettement perturbé par la lumière blanche tandis qu'il ne l'était pas à la lumière rouge [1].

Les „actographes" permettent d'obtenir une représentation graphique de l'activité des Insectes. Nous avons réalisé un actographe du type de celui de SZYMANSKI avec des modifications permettant son emploi pour mesurer l'activité d'espèces ne pesant que quelques milligrammes (Fig. 2). Cet appareil diffère essentiellement des autres par sa pointe traçante formée d'un crin coupé en biseau et portée elle-même par un ou deux crins fixés à la cage construite en matière plastique et comportant une partie coulissante permettant de régler l'équilibre et d'introduire l'animal. L'inscription se fait sur un cylindre (tournant en 24 heures ou en une semaine) recouvert d'une

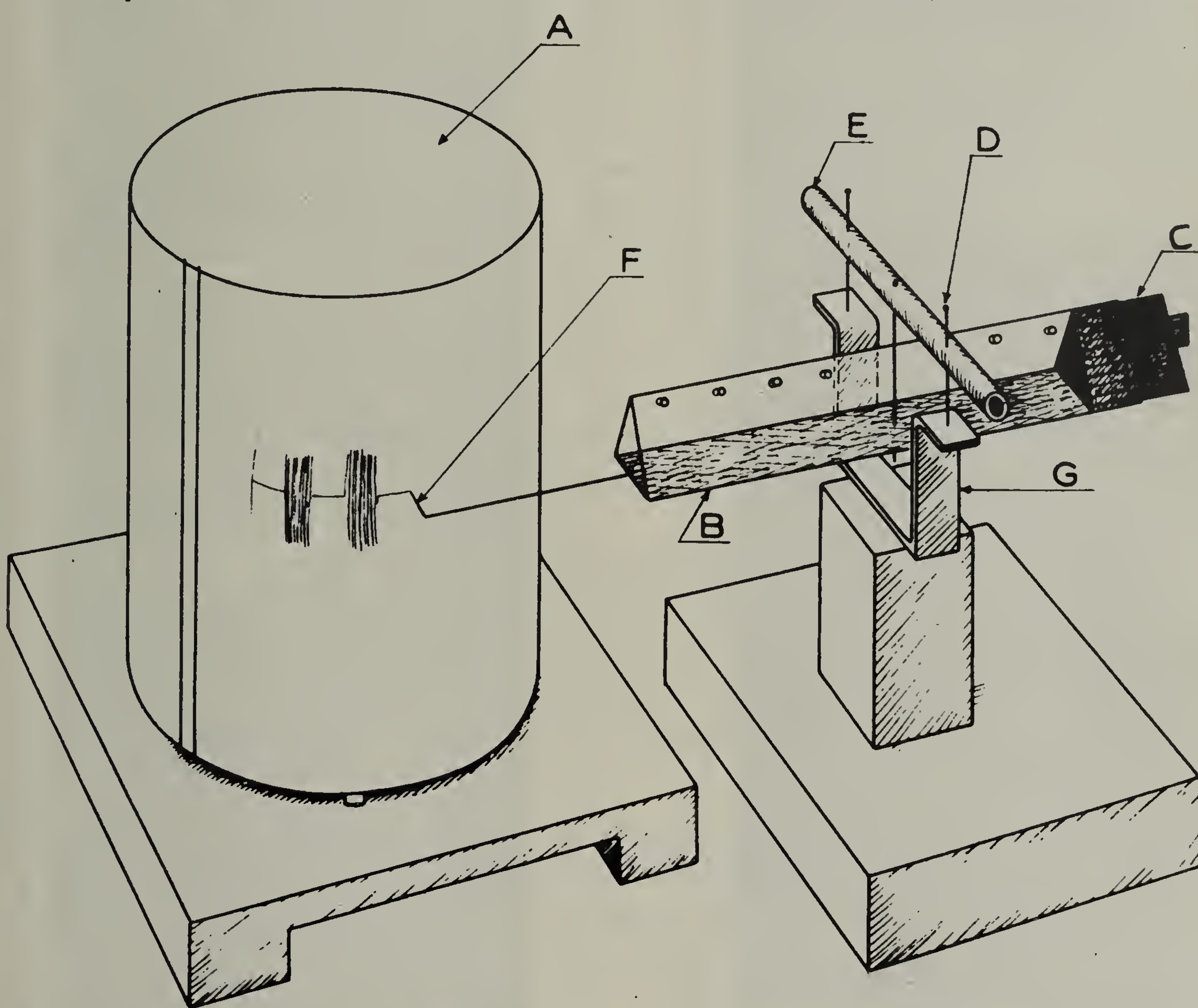


Fig. 2. Actographe. A-Cylindre enregistreur – B. Cage en matière plastique – C. Partie coulissante noircie permettant de régler l'équilibre et d'introduire l'Insecte – D. Epingles servant de pivot – E. Morceau de Bambou – F. Pointe traçante formée d'un crin taillé en biseau – G. Etrier métallique.

1) Ce cas est d'ailleurs courant chez les animaux phototactiques négatifs.

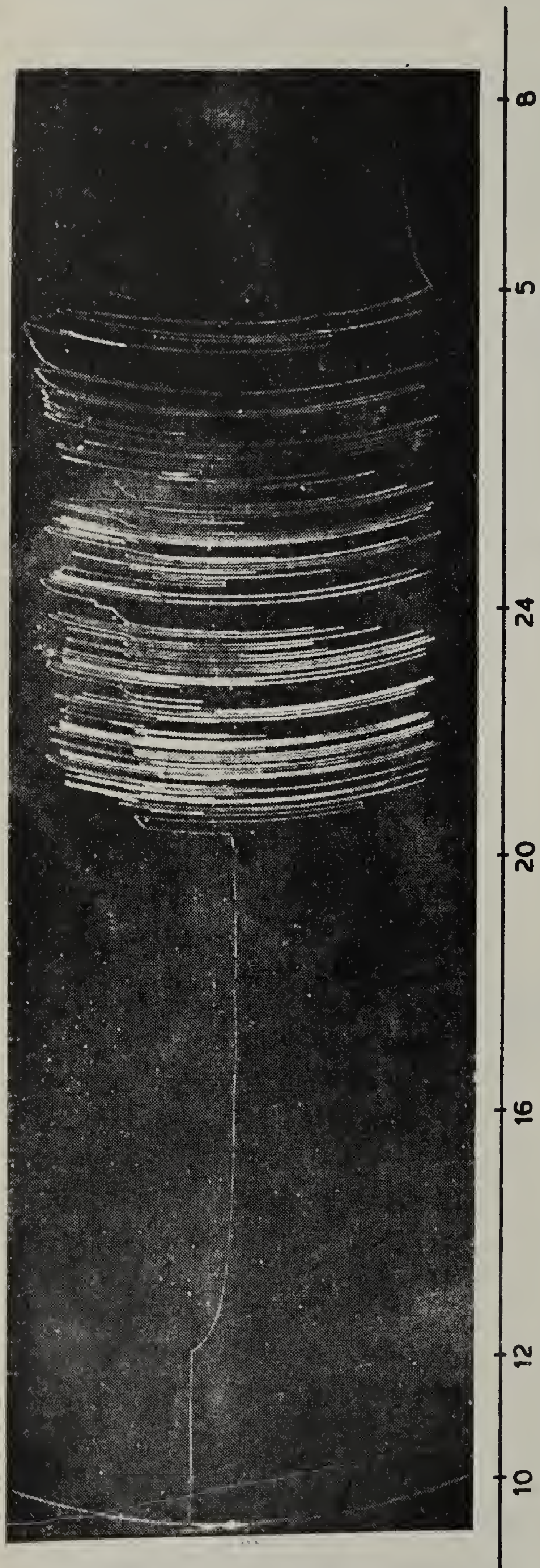
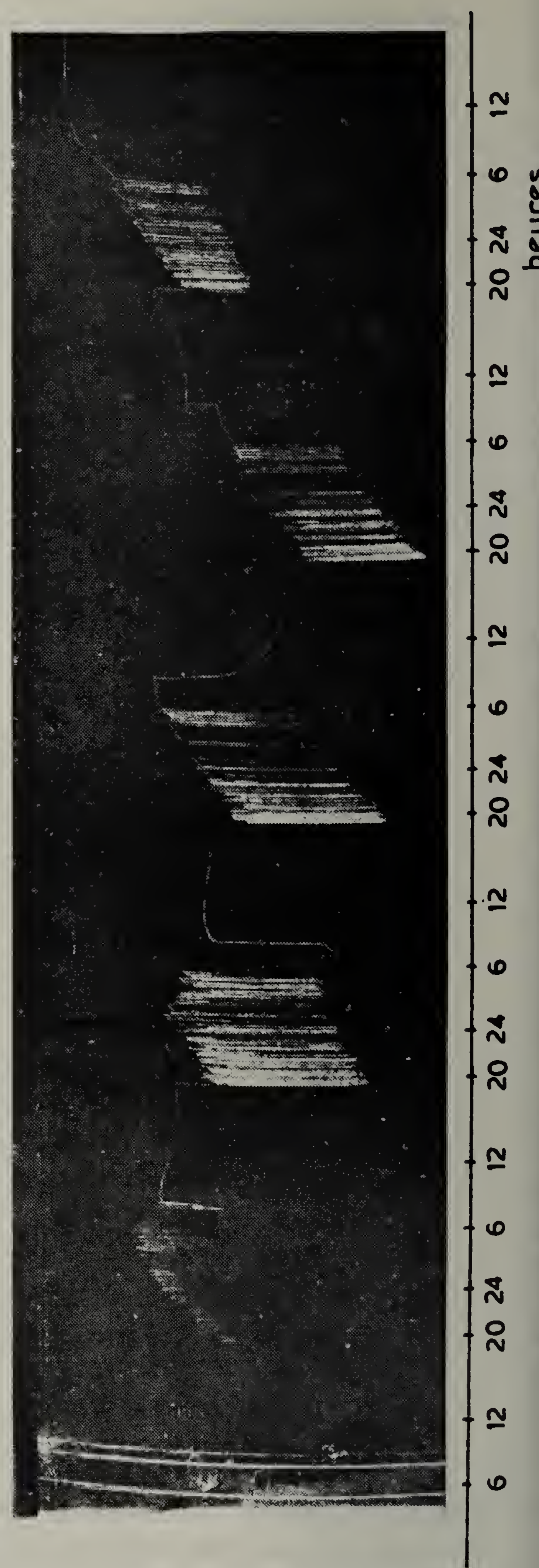


Fig. 3. Actogramme d'*A. obscurus* montrant une grande activité cinesthésique entre 20 et 5 heures. (du 25-V au 26-V-'51).



bande de papier glacé passée au noir de fumée; cette dernière, lorsque le travail est terminé, est fixée à l'aide d'une solution de collophane dans l'acétone. La fréquence et l'amplitude des oscillations du stylet inscripteur permettent d'évaluer l'intensité de l'activité. Les graphiques obtenus dont nous publions deux exemples, parmi un grand nombre, indiquent nettement une activité nocturne entre 19 h. et 6 h. (G.M.T.) avec une période d'activité maxima entre 19 h. et 23 h. (G.M.T.) 1). Des graphiques de ce genre furent obtenus toutes les fois que la température ne descendait pas au-dessous de 5° C. pendant la nuit et ne montait pas au-dessus de 20° C. pendant le jour. Ce rythme continue en l'absence de nourriture.

L'étude de certains facteurs abiotiques (en particulier température et luminosité) pouvant influencer ce comportement a été conduite en faisant varier ces facteurs dans les conditions de l'expérimentation en actographe. C'est ainsi que nous avons pu voir l'action de la luminosité en noircissant la cage de l'actographe ou au contraire en la soumettant à un éclairement continu.

La comparaison des nombreux graphiques d'actographe obtenus nous a permis de formuler les premières remarques suivantes:

Il semble que l'activité cinesthésique des imagos d'*Agriotes* soit fonction de la température. Cette activité étant „normale" entre 5° C. et 20° C. Au-delà de 25° C. l'activité est intense et tend vers un état „anormal" (semblable à une surexcitation nerveuse). C'est ainsi que dans la nature par des journées de fortes températures on remarque de nombreux déplacements d'adultes et des tentatives de vol. Au-dessous de 5° C. nous assistons à une baisse graduelle de l'activité aboutissant à l'immobilisation totale.

Le rythme nycthéméral (déplacement de nuit et repos de jour) semble essentiellement dû à la luminosité. La lumière blanche inhibe l'activité cinesthésique.

D'autre part elle provoque un phototactisme négatif qui, dans la nature amène les Insectes à se placer dans des abris obscurs quelconques pendant le jour; au laboratoire cette réaction est mise en évidence par l'expérience suivante: des adultes d'*Agriotes* sont placés dans des boîtes de Pétri de différentes présentations et des notations effectuées pendant le jour toutes les deux heures:

1) couvercle à demi noirci;
2) couvercle à demi noirci avec abri transparent dans la partie noire;
3) couvercle à demi noirci avec abri transparent dans la partie claire;
4) boîte entièrement noire avec abri transparent;
5) boîte non noircie avec abri transparent et abri noir;
6) boîte non noircie avec abri transparent.

Les résultats résumés dans le tableau ci-après montrent un net phototactisme négatif et dans le cas où il n'y a pas de choix (no 6) un certain tignotactisme semble se manifester.

1) PARK, LOCKETT et MYERS (1931) ont fait des remarques analogues sur le rythme nocturne d'animaux forestiers.

	No	Partie obscurcie	Partie non obscurcie	Abri transparent	Abri noir
couvercle à demi obscurci	1	99%	1 %		
	2	93%	6%	1 %	
	3	99%	1 %	0 %	
Entièrement noir	4	90%		10 %	
Entièrement transparent	5		15 %	0 %	85 %
	6		19 %	81 %	

Dans les actographes, les *Agriotes* non exposés à la lumière perdent leur rythme [1]. Nous avons tenté de renverser les conditions de luminosité, éclairement de nuit et obscurité pendant le jour, et les premiers résultats obtenus indiquent la même inversion dans l'activité [2]. De nouvelles expériences nous permettront de développer ces éléments ainsi que l'influence de la qualité et de l'intensité lumineuses.

L'hygrométrie ne semble pas intervenir comme facteur influençant l'activité de déplacement. Cependant un certain degré hygrométrique est nécessaire à la vie des adultes (autour de 50% d'H.R.).Dans la nature la pluviosité peut gêner considérablement le déplacement des imagos et leur groupement sous les Bottillons attractifs.

Enfin il est vraisemblable que l'ensemble de l'activité des adultes d'*Agriotes* suive les mêmes conditions que l'activité de déplacement: c'est ainsi que l'alimentation a surtout lieu pendant la nuit (expériences de laboratoire et observations dans la nature).

Ces remarques sur les facteurs influençant l'activité de déplacement nous expliquent le fait que les Taupins s'enterrent ou s'abritent pendant le jour pour entrer en activité la nuit. D'autre part, les déplacements de jour (observés par de nombreux auteurs et par nous-mêmes) pourraient trouver leur cause soit dans une température élevée (plus de 25° C. qui intensifie l'activité et tend vers un état anormal avec parfois tentatives de vol (forte hygrométrie), soit dans une diminution de l'éclairement ce qui confirmerait les observations de M.V. BRIAN sur la relation entre la réduction de l'intensité lumineuse par les nuages et l'apparition d'une certaine activité chez les *Agriotes*.

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1) Dans un récent travail (juin 1951) dont nous avons pris connaissance après la rédaction de cette note, J.L.CLOUDSEY-THOMPSON a étudié les rythmes journaliers (diurnal rythms) chez les Myriapodes.

2) D'autre part nous avons réalisé une inversion du rythme chez un Insecte à activité diurne = *Leptinotarsa decemlineata* Say en le soumettant dans un actographe, à un éclairement pendant la nuit et à l'obscurité pendant le jour. Un même changement de rythme avait été observé par F.E.LUTZ (1932) chez le grillon domestique.

En résumé nous pouvons remarquer que l'activité de déplacement des adultes d'*Agriotes obscurus* L., *lineatus* L. et *sputator* L. est fonction de la température et qu'elle est *optima* entre 5° C. et 20° C. environ. Le rythme nycthéméral (déplacement de nuit et repos de jour) que l'on observe aussi bien dans la nature qu'en laboratoire (actographe) est dû à la luminosité, la lumière blanche inhibant l'activité de déplacement. Il semble que ce comportement rythme intéresse toute l'activité de l'Insecte (alimentation, copulation, ponte) et non pas seulement les déplacements.

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DISCUSSION

Mr. **Labeyrie**: Est-ce que l'expérience sur le phototactisme avec les boîtes de Pétri a été effectuée à plus de 25° C? Est-ce que l'intensité lumineuse a été étudiée, avez-vous trouvé un seuil inhibiteur?

Mr. **d'Aguilar**: Non, ces expériences n'ont pas été faites.

Mr. **Cloudsley-Thompson**: Est-ce que l'activité de vol peut exister pendant la nuit bien qu'elle ne puisse pas être observée? Est-ce que la température constante pour longtemps a un effet nocif sur les animaux? Connaissez-vous quelques insectes dans lesquels les variations en humidité ont un effet sur le rythme?

Mr. **d'Aguilar**: Nous avons fait un certain nombre d'observations de nuit et nous n'avons jamais observé de vols de nuit. Il semble bien qu'une température constante élevée amène une mort assez rapide en actographe. Je n'ai pas eu l'occasion d'étudier cette question sur d'autres insectes.

Mr. **Franz**: Das Ergebnis in Petrischale 6 scheint zu zeigen dass die Lichtqualität das Verhalten der *Agriotes*arten beeinflusst. Sind hierüber schon Untersuchungen angestellt worden?

Mr. **d'Aguilar**: Il semble en effet que l'intensité et la qualité de la lumière ont une action sur le rythme d'activité des *Agriotes*. Nous comptons poursuivre ces observations afin de préciser cette question.

THE CHINESE JUTE- OR HOLLYHOCK MOTH CROCIDOSEMA PLEBEIANA, ZELL. AS AN ANTICIPATED COTTON PEST

by
H.E.M.S. EL-ZOHEIRY BEY & M.A. ASEM
Cairo, Egypt

Introduction

The Hollyhock moth, *Crocidosema plebeiana,* Zell. has been recorded in Egypt since 1914 when its moths emerged from breeding of larvae feeding in vegetable-marrow (Cucurbita pepo) collected from Giza, near Cairo.

In April and May 1916 the moths of the same insect were bred from larvae collected from Hollyhock (Althaea rosa) at Meadi, about 12 kms. south of Cairo. Moths were also captured from the same locality in September 1917. In 1919 Hollyhocks grown in the gardens of the same locality were found infested with larvae of *Crocidosema plebeiana.*

In January 1930 the moths were captured on lights at Heliopolis, east of Cairo.

The first record of an attack of *Crocidosema plebeiana* on cotton was made by F.C.WILLCOCKS, Entomologist to the Agricultural Society, Egypt. In his book, "The more important Insects and Mites feeding on Agricultural Crops", p. 29 he mentioned the following:

"The Hollyhock moth *(Crosidosema plebeiana,* Z.) is, as its name implies, an insect which feeds normally on the Hollyhock (Althaea), but a single specimen of this species has been bred from a larva which was tunneling in the terminal part of the stem of a cotton plant received from Mr. SALVAGO, Behera (northern province of the Delta).

So far as I know, it is unusual for *Crocidosema plebeiana* to attack cotton; on one other occasion only has it been noted in connection with cotton, an egg being found on a green boll at Ghezireh (Cairo) in 1915."

In vol. 1, part 2 "Insects and Mites injurious to the Cotton Plant" by F.C. WILLCOCKS & S. BAHGAT, pub. 1937 they mentioned on p. 403:

"*Crocidosema plebeiana,* Zell., the Hollyhock moth, so far of no importance to cotton; found only twice on cotton."

but on page 701 they said:

"The caterpillar will definitely attack sound cotton bolls, but fortunately it seems to be a very rare species in the cotton fields. Probably there are wild Malvaceous host-plants on which it feeds. Hollyhocks are not rare in Egyptian gardens, but they are not extensively grown. In the Sudan this caterpillar feeds on Abutilons."

Crosidosema plebeiana had also been reported in two other countries; in the report of the director of cotton culture, Queensland, 1943, 11–12, he stated that

"the tip worm "*Crocidosema plebeiana,* Zell. which was the only pest of any consequence attacking seedlings, destroyed a considerable number of terminals in early-planted cotton in the Callide Valley, where it had not previously attracted attention."

In the R.A.E., 1947, 420, it was stated that

"the larvae of this species mined in the shoots and attacked the young bolls in :aly."

It is not strange therefore to anticipate that *Crocidosema plebeiana,* Zell. ·ill be in the near future an important cotton pest under favourable ecolo-·ical conditions. Why, then, is it not yet a cotton pest of any consequence n Egypt where ecological conditions are favourable for insect multiplication? t has been mentioned by WILLCOCKS that there must be malvaceous host-·lants on which the insect feeds; these plants were not known before 1949 ·hen Chinese Jute (Abutilon avicinnae, Gaertn.), also known as American Jute, ·merican velvet leaf, Manchurian Jute, and Lantern Flower (Fam. Malvaceae) 'late I, grown in an area of 4 acres for experimental purposes on the farm of ·he Faculty of Agriculture, Farouk Ist University, Alex., was found by the ·riters badly infested.

The attack caused gall formation at the tips of the terminal shoots (figs. 1 o 6 Plate II, D.E.F. Plate III) and in the bases of the leaf axils, each gall ·ontaining 3 to 4 larvae.

The growth of the attacked plants was retarded. Three generations were bred ·n this plant from June to September.

Other species of Jute of the family Tiliaceae, viz. Corcharus capsularis and ·archarus olitorius grown on the same farm close to the Chinese Jute were ·ot attacked.

In 1950 a severe attack of the Chines Jute occurred on the experimental farm ·f the Ministry of Agriculture which is very close to the farm of the Faculty n Alexandria.

The Chines Jute which is grown in Egypt since 1920 served as a trap crop ·f this insect. Together with Hollyhocks these two Malvaceous host-plants ·aved the cotton from this insect. The writers therefore recommend the cul-·ivation of Chinese Jute on the outskirts of cotton fields as a trap crop for ·his insect in Egypt and wherever this insect is a pest of cotton. The galls ·ormed on the plants in each generation should be destroyed before the emer-·ence of the moths.

.ife History

The female lays its eggs on the bases of the leaf axils, on terminal vege-·ative and flower buds and on the flowers, in clusters of 3 to 4 eggs. The ·umber of eggs laid by one female and the incubation period of the eggs are ·ot known for certain; at present there are insufficient records.

After hatching, the larvae bore into the tissues of the terminals causing ·all formations. Larvae from eggs laid on flowers, eat holes in the petals ·nd bore into the ovary.

·wo to four larvae are found in each gall and an average of 6 galls are formed ·n each plant. Recently hatched larvae are greenish white in colour, one mm. ·ong; head light brown; thoracic shield dark brown. Larval instar from 12 to ·5 days in summer. Full grown larvae (fig A Plate III) 12 mm. long, pupate

Plate I

Chinese Jute, Abutilon avecinnae Gaertn. host-plant of *Crocidosema plebeiana*, Zell.

Plate II

Gall-formation in Chines caused by *Crocidosema pl* Zell.

PLATE. III

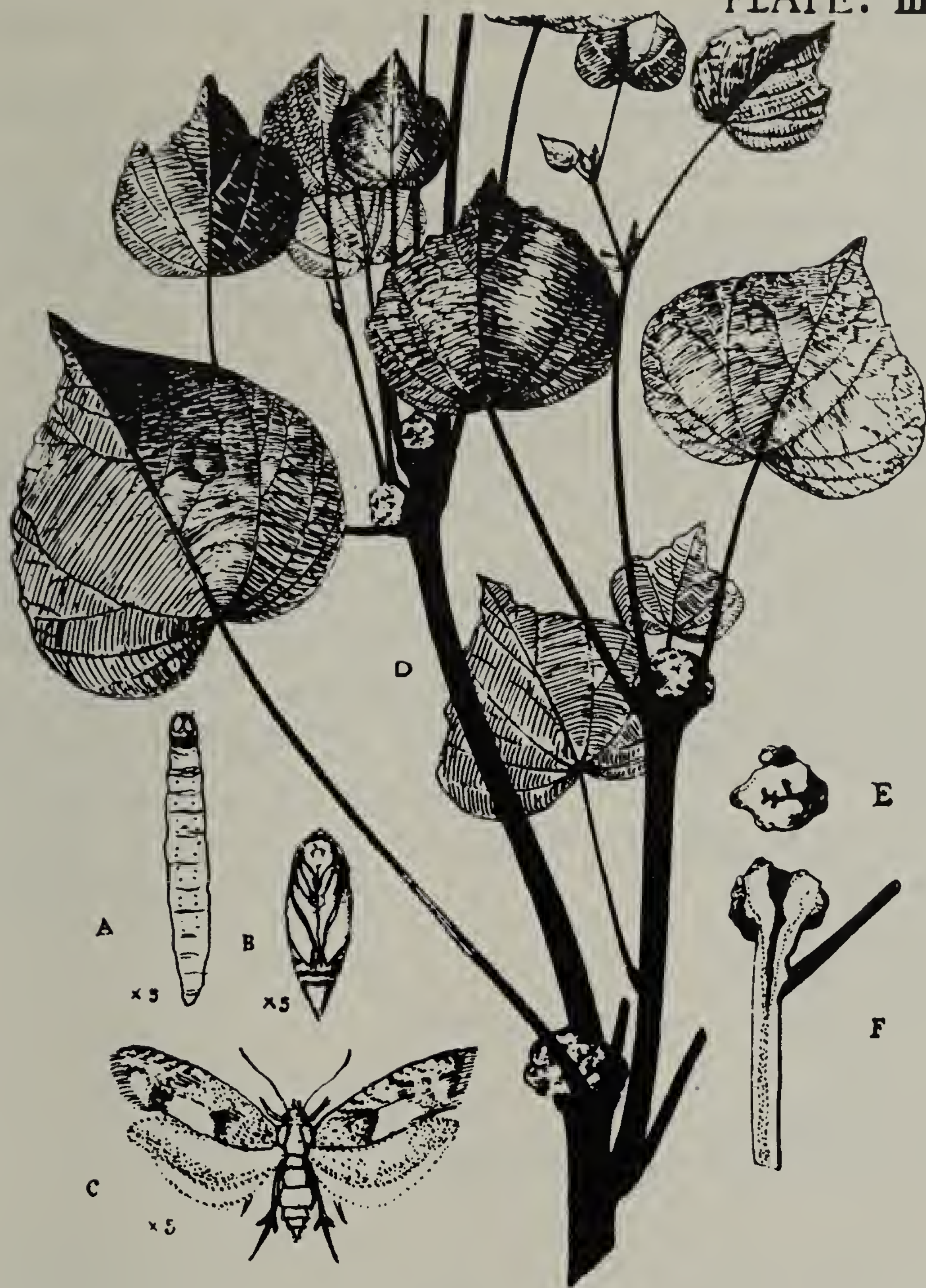

Plate III

Larva (A), Pupa (B), Imago (C) of *Crocidosema plebeiana*, Zell. Galls (D, E and F) caused by this insect.

side the gall. Pupae (fig B Plate III) light brown, 3.5 mm. long. Pupal in- ar 10 to 12 days. Moths (fig C Plate III) emerge through the splits of the ened tissues of the dry galls.

The first generation on the Chinese Jute begins about the end of the first eek of June when the plants are about two months old. Three generations eed on the Chinese Jute, from June to September. Earlier generations occur Hollyhocks. It is interesting to note that larvae of the Spiny Bollworm, *arias insulana*, Boisd., were found inside some galls with the larvae of *rosidosema plebeiana*, Zell. Both Hollyhocks and Abutilons are also host- ants of *Earias* in Egypt.

Nature of Injury

The attack of *Crosidosema plebeiana*, Zell. causes the following injuries to the Chinese Jute:

a) Gall formation and multiple branching below the galls and the attacked buds.
b) Retardation of growth and dwarfing of the plants; the Chines Jute being a fibre plant gives a poor yield of short fibres due to attack.
c) Poor yield of seed follows the attack of flowers.

Control Measures

Effective measures for the control of this insect on the Chinese Jute in 1950 were the pruning of infested parts of the plant and the destruction of galls by burning outside the field.

Preliminary experiments carried out in 1951 with B.H.C. (% 5 wettable) a a concentration of %l, Gezarol (% 10 DDT wettable) at a concentration of % spray, gave satisfactory protection of young plants.

The soaking of gall formations with Carbon bisulphide killed the larvae within the galls.

A survey of other host-plants viz.:

1) Amaranthus blitoides
2) Chenopodium album
3) Chenopodium robrum
4) Epilobium hirsutum
5) Hieracium spp.
6) Polygonum aviculare
7) Portulaca oleracea (wild and cultivated)

is being made as they are known under the general name of pigweed which i a host of the same species of insect. Chenopodium was the only weed whic was found infested in 1951. The eradication of this weed will help in sup pressing the population of this insect.

The fact that this insect is a pest of the Chinese Jute grown in the Nort of the Delta nearest to Alexandria, and that the Chinese Jute grown in othe localities in the interior is free from attack, shows that ecological condition in the former district are favourable for this insect. The abundance of Holly hock in this same district is an important favourable factor.

To protect cotton grown in this district it is, at present temporarily recom mended to cultivate the Chinese Jute in small areas as a crop as well as trap crop for this insect.

Summary

Crocidosima plebeiana, Zell was known to occur in Egypt since 1914 no mally feeding on Hollyhocks. It was found only twice on cotton, and is nc yet a cotton pest of any consequence in Egypt. It has been reported as

serious pest attacking cotton seedlings in Queensland, and attacking terminal shoots and young cotton bolls in Italy.

Egyptian cotton has up till now been protected from its attack because it feeds on other Malvaceous plants; until 1948 its known primary host-plant was the Hollyhock; in 1949, Manchurian or Chinese Jute, which was introduced into Egypt about 1920, was found heavily infested with this pest. The attack caused gall formations on the plant, multiple branching, retardation of growth, dwarfing, short fibres, and poor yield of seed. Chinese Jute, cultivated as a hedge to cotton fields or in small areas in close proximity to cotton, served as a trap crop to this insect. Pigweed "Chenopodium" which grows wild in cotton areas was also found infested, August 1951.

It is to be anticipated that this insect will become a pest of cotton under favourable ecological conditions in Egypt. Eggs are laid in small clusters (3 to 4 eggs). Total number of eggs laid by the female not yet known. Three to four larvae live inside the gall, sometimes with larvae of *Earias insulana*, Boisd. Life cycle about one month. Several (?) generations a year; three generations on jute. D.D.T. and B.H.C. sprays protected young plants. Carbon bisulphide killed the larvae inside galls.

The writers recommend the cultivation of Chinese Jute as a trap crop to protect cotton from this pest.

SURVIVAL OF A CHIRONOMID LARVA AFTER 20 MONTHS DEHYDRATION

by

H. E. HINTON
Bristol, Great Britain

It is well known that certain invertebrates, such as some protozoa, rotifers, and the Tardigrada amongst arthropods, are able to survive extreme dehydration for prolonged periods, but the ability to survive dehydration of this degree has not been previously recorded for any insect. The stages of insects known to survive in relatively dry environments for long periods without taking up water survive only because they are enclosed in relatively impermeable membranes. The larva of the Chironomid, *Polypedilium vanderplankei* Hinton (1951), however, has already been found to survive without apparent injury the loss of most of its water for 20 months, and there is now no reason to believe that this period may not be extended to several years.

The Habitat and Habits of the species

Polypedilium vanderplankei breeds in pools formed in shallow hollows on unshaded granite rocks. The larvae used in my experiments were collected by Dr. F.L.VANDERPLANK at Anara, alt. 2.500 ft., which is about 20 miles S.E. of Kaduna in Northern Nigeria. The hollows at Anara are on a granite rock about 30 ft. high and nearly an acre in area. They are about 18 by 9 inches and are 5–9 inches deep. The rainy season at Anara lasts from about March to the middle of October. The rains begin in March, and the pools fill and dry three or four times during March and April. From May until September they are kept filled and must regularly overflow. In September they dry again and may fill and dry two or three times before the rains end in the middle of October. Occasional storms that may fill the hollows occur between November and the end of February. Dr. VANDERPLANK found that the temperature of the wet mud one afternoon in January was 40° C. In the dry season shade temperatures often rise to a little above 40° C.

The length of the life-cycle has not been accurately determined, but even at temperatures just under 40° C. the larvae require about two weeks to complete their development. It seems clear that if a small flightness animal is successfully to invade the small, shallow, temporary rock pools, it must be able to survive when the pools suddenly dry. The final stages of drying must often take place during the day, and a long journey across the hot granite rock is not a possibility for a very small animal. It is an interesting fact that, apart from two dead Hydrophilid larvae and the remains of adult beetles, the only animals found in the dry mud sent to me from Anara were protozoa, a species of rotifer, and a free-living Nematode. All of these were very abundant. All could be dehydrated, and all could survive when active or dry the

temperatures tolerated by the Chironomid. The remains of adult Hydrophilid beetles found in the dry mud seem to show that the pools are also colonised by insects that can fly away when the water evaporates. Since the early stages of these do not survive when the pools dry, their colonization of the pools is entirely dependent on the existence in the neighbourhood of pools or streams that are very much less temporary. The survival of the Chironomid, on the other hand, is probably not directly dependent on the existence of other aquatic environments.

Owing to the length of time required to complete their development, it seems likely that the Chironomid larvae will sometimes be exposed to repeated dessications. It was found that some larvae survived being dried for 24 hours, reactivated in water for three hours, dried again for 24 hours, and so on until they had been dried out no less than three times separated by intervals of three hours, when they were reactivated until they had begun to feed.

Under natural conditions very few larvae dry in their slight silken tubes. At some stage in the drying process they probably leave their tubes in search of water. At room temperatures and humidities (about 40–60%) in clay of 3% moisture content, the moisture content of the larvae was 15–20%. When dehydrated the metabolic rate is very low, as is shown by the fact that the oxygen consumption of a dehydrated larva is 171 times less than that of an active larva of the same size (Table I) (See also Note after Discussion).

TABLE I

Oxygen consumption of dehydrated and active larvae in a water bath at 35.5° C. Manometric figures are in each case the sum of corrected readings over a period of 27–28 hours.

	71 dry larvae	1 ml. medium	6 larvae in 1 ml. medium
ml.	− 2.5	− 25.5	− 66.5
constant	1.8	1.61	1.63
$\mu l\ O_2$	4.5	41.1	108.4
$\frac{\mu l.\ O_2 \text{ per larva}}{\text{hour}}$	0.0023		0.3933

When the dry larvae are placed in water, water seems to be absorbed fairly uniformly, and it does not appear to be more rapidly absorbed through the anal papillae than through the anal prolegs. Experiments with the pupae show that they cannot survive dehydration. The eggs also do not seem to be able to survive being dried. Of the many thousands of larvae reactivated from

dry mud, none were under 2.2 mm. in length, which is some evidence that neither eggs nor recently hatched larvae tolerate dehydration.

Effect of high temperatures on active larvae

Experiments on the temperature tolerance of active larvae are described in detail elsewhere (HINTON, 1951). Active larvae survive water temperatures up to 41° C. for continuous periods much longer than any they encounter under natural conditions, e.g. 14 hours. A few larvae were also found to survive and produce adults after exposure to 43.5° C. for 14 hours. Although the shade temperatures of Kaduna often rise to a little above 40° C., evaporation will certainly prevent the water from reaching a similar temperature. It is possible that in the last stages of drying the mud may reach a temperature of about 40° C. but then only for a very short period.

Effect of high temperatures on dehydrated larvae

In preliminary experiments with larvae that had been dehydrated to 15–20% moisture content for 18 months, it was found that they survived 20 hours at 65° C., and that the critical temperature was between 65° C. and 70° C. The results of the experiments listed in Table II show that a high proportion of larvae survive temperatures about two degrees below 70° C. for continuous periods much longer than those to which they are exposed in their normal environment. When exposed for 2.30 hours at 69.5° C. (3, Table II) a few survived, but in this experiment some fragments of soil with a minimum diameter of 15 mm. were used, and it is quite possible that in 2.30 hours the temperature of the middle of the largest fragments had either not reached 69.5° C. or had reached this temperature only for a very short time.

TABLE II

Effect of high temperatures on larvae dehydrated to 15–20% moisture content for 18 months. All pieces of dry mud used were 7–25 mm. in diameter.

	°C.	Hours	Number	Dead injured	Dead uninjured	Later died	Survived	% Survi
1	61	14	34	4	–	2	28	93.
2	68.5	11	48	13	24	2	9	25.
3	69.5	2.30	43	5	22	11	5	13.
4	69.5	11	32	3	25	4	–	0

The top and bottom sides of the caked mud sent to me are easily recognizable as such. On the top there is a layer consisting chiefly of plant debris.

Between this and the thicker bottom layer, that consists mostly of clay, there is a narrow and indefinite transition zone. The top layer of plant debris is easily abraded. The fragments are about 30 mm. thick, and the top layer is 5–7 mm. thick. There can be little doubt that the top layer has already been thinned by abrasion. In order to determine the approximate vertical distribution of the larvae in the caked mud, a large fragment was sectioned with a razor blade. Most of the larvae were 8–15 mm. deep, a few were only 3–5 mm. deep, and none were found below 20 mm.

The shade temperatures of Kaduna often rise to a little above 40° C in the dry season, which is from the middle of October to the end of February. So long as a thick top layer of plant debris is present, it is hardly likely that any of the larvae will be exposed to temperatures as high as 60° C. But this top layer is loosely bound, and it may be safely supposed that long before the end of the dry season much of it is blown away. The fragments sent to me were collected in December, when the top layer was not more than about 7 mm. thick. Near the end of the dry season, or before if the rock hollows are in an exceptionally exposed position, it seems likely that much or all of the top layer will sometimes be blown or eroded away.

BUXTON and others have shown that the surface temperatures of fine soils may rise as much as 20–30° C. above shade temperatures. If the protective layer of plant debris be completely removed, surface temperatures on the hottest days may be as high as 70° C. or a little higher, say 80° C., owing to radiation from the rock sides of the hollows. Surface temperatures of 80° C. will not be maintained in any one day for more than a few hours at most. Assuming that dehydration for 18 months has not appreciably lessened the ability of the larvae to withstand heat, it is clear that any larvae on the surface of the clay layer will be killed. Others have shown that there is a steep fall in temperature away from the surface such that when the surface temperature is 80° C. the temperature at 4 mm. is 70° C. and that at 8 mm. is 60° C. In the fragment sectioned 54.5 % of the larvae found were 4 mm. or deeper in the bottom layer and 22.7 % were 9 mm. or more below the surface of the bottom layer. It is thus clear that even if all of the top layer of plant debris be eroded away, and temperatures on the surface of the bottom layer rise as high as 80° C., a high proportion of the larvae will nevertheless survive.

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DISCUSSION

Mr. **Varley**: Did any of the chironomids reach the adult stage? Did you try longer periods at high temperature than 5 minutes?

Mr. **Hinton**: Most of those that survived the temperature experiments pro-

duced adults. At temperatures of 150° C and over, larvae were exposed for only 5 minutes. Experiments in the range 100°–200° C were made from idle curiosity: they have no biological significance.

Mr. **Burtt**: Is the water absorbed by the larva as a whole?

Mr. **Hinton**: Yes. Of course the speed of water absorption is probably less through the thicker cuticle of the head. The anal gills do not appear to absorb water more rapidly than parts of the abdomen and thorax.

Note of Mr. **Hinton** to Table I: However, the Warburg is too insensitive for this work, and I suspect that in the dried state respiration, if any, is anerobic.

EMBIOPTERA OF TRINIDAD WITH NOTES ON THEIR PARASITES

by
E.McC. CALLAN
Grahamstown, South Africa

At present eight families are recognized in the Embioptera (DAVIS, 1940) with about 42 genera and some 170 species. The Embiidae are represented by endemic genera in both the Old and New World, while the Clothodidae, Oligembiidae, Anisembiidae and Teratembiidae are restricted to America. The Oligotomidae are Old World (except *Gynembia* Ross), but a few species have become widely distributed by man. The Notoligotomidae include Indo-Malayan and Australian forms and the Protembiidae are only known from the Permian of the United States and Russia.

Five of the eight known families of Embioptera are represented in Trinidad, British West Indies. This island, some 1.750 square miles in area, lies off the coast of northern South America and its fauna and flora have close affinities with those of the adjacent part of the mainland. The following observations were made over a period of several years, when the writer was on the staff of the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, and are based largely on ROSS's (1944) revision of the Embioptera of the New World. To the late Mr. Consett DAVIS and Dr. Edward S.ROSS I am greatly indebted for their kindness in studying material from Trinidad.

Clothodidae

This family includes the most primitive of living embiopterons. They are very large forms with the male terminalia simple and scarcely asymmetrical and the cerci quite symmetrical. Distribution is neotropical and *Clothoda* Enderlein is the only genus. Three species and one subspecies have been described. A fossil web-spinner from the Miocene of the United States is also rather doubtfully ascribed to this genus.

Clothoda urichi urichi (Saussure) is the best known form and is common in Trinidad. It has been redescribed and figured by DAVIS (1942), who states that the males measure 10.5 to 14.0 mm in length and the females up to 16 mm. There is considerable variation in size, however, and in my collection are males which measure 16 mm. and females almost 20 mm. in length. I have examined numerous specimens in which the antennae do not agree with DAVIS's description. In my material there are almost invariably 22 segments; the last three are cream in the female and in the male the terminal four segments are cream with the last one tipped with brown. The males have dark wings, the veins being bordered by smoky-brown bands. The forewings measure 12 mm. long and 3 mm. wide in the largest specimens.

Due to variability in the branching of the cubitus of the wing in Trinidad specimens DAVIS (1942) believed *C. intermedia* Davis, described from Venezuela, to be a synonym of *C. urichi*, but ROSS (1944) regards *intermedia* as a mainland subspecies of

urichi. In examining six males from Trinidad, DAVIS (1942) found the cubitus 3-branched in all wings in one specimen, 2-branched in all wings in two specimens, and some of the wings with a 2-branched and others with a 3-branched cubitus in the remaining specimens.

I have had the opportunity of studying a further fifteen males from Trinidad. The cubitus was 3-branched in all wings in two specimens, in seven specimens it was 2-branched in all wings, and in the remaining specimens some of the wings had a 2-branched and others a 3-branched cubitus. These results are presented in Table 1.

TABLE 1

Variability in the branching of the cubitus in males of *Clothoda urichi urichi* (Saussure) from Trinidad

	All wings 2-branched	3 wings 2-branched 1 wing 3-branched	2 wings 2-branched 2 wings 3-branched	3 wings 3-branched 1 wing 2-branched	All wings 3-branched
DAVIS (1942)	2	2	–	1	1
CALLAN	7	4	1	1	2

ROSS (1944) states that the Venezuelan specimens studied were larger and darker than those from Trinidad, but size cannot be taken as a criterion, as Trinidad individuals often attain the dimensions of the mainland forms. Until the collection of extensive series demonstrates that the cubitus is predominantly 2-branched in Trinidad specimens and 3-branched in Venezuelan material, it is difficult either to agree with DAVIS that but one species is involved, variable in regard to the branching of the cubitus, or to subscribe to ROSS's view that two subspecies exist.

In temperate countries embiopterons are usually encountered in the wet season on the ground often at the roots of plants, retreating into silken tunnels in the soil when the weather becomes dry. In arid regions they frequently occur under stones. In Trinidad and probably in other wet tropical countries their silken webs are invariably found well above the ground. These are almost always on the trunks of trees, especially in crevices in the bark and under loose bark, and not infrequently at the base of epiphytic orchids and bromeliads. The white webs are often very conspicuous on the tree and may cover an extensive area of the trunk.

In Trinidad *C. u. urichi* is commonly found in colonies on the trunks of citrus, cacao, mango and other trees in settled areas and in secondary forest throughout the island. It has also been found on tree-trunks in primary lower montane rain forest in the Northern Range mountains. Several embiopterons have been reported to cause injury to the roots of orchids, and FRIEDRICHS (1925) mentions that the late Professor F.W.URICH found this species damaging orchids in this way in Trinidad.

Embiidae

This is the largest family of Embioptera. Distribution is both Old and New World and over twenty genera are known. Five genera are neotropical, and seventeen species and one subspecies have been described from this region.

Pararhagadochir trinitatis trinitatis (Saussure) is the best known neotropical form and is common in Trinidad. It has been redescribed and figured by DAVIS (1942), according to whom the males measure 6.5 to 8.7 mm. and the females 6.5 to 9.8 mm. in length. Specimens in my collection agree well with these dimensions. The prothorax is cream in contrast with the rest of the body which is brown. The antennae have up to 23 segments. The males have dark brown wings with smoky-brown bands along the veins. The fore-wings measure 7.0 mm. long and 1.6 mm. wide in the largest specimens.

P. t. flavicollis (Enderlein), known only from Bolivia, is regarded by ROSS (1944) as a mainland subspecies. ROSS (1944) mentions that additional specimens from Venezuela and Colombia differ in several characters and may be shown eventually to comprise further subspecies.

In Trinidad *P. t. trinitatis* is invariably found well away from the ground, colonizing tree-trunks in much the same way as *C. u. urichi*. It is commonly encountered beneath silken webs on trees in settled areas in many parts of the island, and has been found also in primary rain forest in the mountains of the Northern Range. FRIEDRICHS (1925) records that the late Professor F.W.URICH observed this species causing damage to the roots of orchids in Trinidad.

Oligembiidae

This family is mainly neotropical in distribution ranging into the warmer parts of temperate America. Three genera are known with some twenty-seven species.

Oligembia armata Ross is a rare but widespread species. The female is unknown. The male has been taken at light in Trinidad, Panama and Mexico. ROSS (1944) described the male holotype from Trinidad, measuring 5.4 mm. in length with forewings 3.5 mm. long and 0.85 mm. wide.

Anisembiidae

This family is neotropical ranging through the West Indies and into warmer temperate North America. Five genera are known and seventeen species have been described.

Schizembia callani Ross is only known from a unique male taken at light in Trinidad. The holotype measures 7 mm. in length and the fore-wings are 4.5 mm. long and 1.2 mm. wide.

Oligotomidae

This is an Old World family (except *Gynembia* Ross), some members of which

are now worldwide in distribution due apparently to the agency of man. Three genera are known, and one genus with three species has become widely established in the New World.

Oligotoma saundersii (Westwood) is pantropical in distribution. In the New World it has an immense range, being widespread from the warmer parts of temperate North America to temperate South America. ROSS (1944) notes that it is found especially near cities and towns. It is quite a common species in Trinidad, and the males are not infrequently taken at light.

Parasites of Embioptera

The associates of Embioptera living with them beneath their silken webs include embiophiles, predators and parasites. Various families of Coleoptera and several Microlepidoptera have been found living with web-spinners. MYERS (1928) found the Monommid beetle, *Hyporrhagus marginatus* (Fabricius), associated with *Mesembia hospes* (Myers) in Cuba and claimed that this species lives with the embiopterons as a facultative embiophile.

Spiders and especially ants are undoubtedly important predators of web-spinners. Reduviids have been noted feeding on them, and on one occasion in Trinidad I observed an Asilid fly catch a winged male of *C. u. urichi.* The most interesting predator, however, is a small hemipteron belonging to the Microphysidae. Dr. W.E.CHINA, to whom I have submitted material, kindly informs me that this represents a new genus and species. Adults and larvae have been found often in considerable numbers with *C. u. urichi* and *P. t. trinitatis* in Trinidad, and have been observed feeding on both the eggs and young larvae of the embiopterons.

The parasites are Hymenoptera and comprise Scelionidae attacking the eggs and Sclerogibbidae parasitizing the larvae. DODD (1939) has described a number of these parasites from Australia. Mr. G.B.WHITEHEAD of Rhodes University informs me (private communication, 1951) that he has also reared a Tachinid fly from the larva of an embiopteron in South Africa. Dr. L.P. MESNIL, to whom the fly has been submitted, reports that it represents a new genus allied to *Rondania* and species. In Trinidad I have reared a Braconid, *Apanteles* sp., in some numbers from white cocoons found under the webs of *C. u. urichi,* but I am inclined to believe this to be a parasite of lepidopterous larvae found occasionally under the webs and not of the web-spinners.

Scelionidae

The first recorded Scelionid egg-parasite of Embioptera was *Embidobia urichi* Ashmead, described from Trinidad by ASHMEAD (1895) as a new genus and species. In Trinidad I have found this parasite to be commonly associated with *C. u. urichi* and *P. t. trinitatis* and have reared it from the eggs of both these species. IMMS (1913) recorded a parasite attacking the eggs of *Parembia valida* (Hagen) (= *Embia major* Imms) in India, which may well be a species of *Embidobia.* DODD (1939) has described *Embidobia australica* Dodd, *E. metoligotomae* Dodd and *E. longipennis* Dodd from various web-

spinners in Australia and *E. orientalis* Dodd from *Oligotoma greeniana* Enderlein in Ceylon.

Further study may show that egg-parasites of the genus *Embidobia* attacking embiopterons are to be found, for example, in Africa, where some fifteen genera of Embioptera occur, as well as in other parts of the world.

Sclerogibbidae

The Sclerogibbidae are a small family of exceptional interest. They may be distinguished from the closely related Bethylidae by having from 22 to as many as 40 segments in the antennae instead of 12 to 13 segments as in the latter family. The females are wingless and the males winged.

As far as is known they are parasites of embiopterons. The family is widely distributed, being found in Europe, Asia, Africa, North America, Australia, Hawaii and Trinidad. It is significant that, although less than a dozen species are known, they all occur within the geographical range of the Embioptera. According to RICHARDS (1939), the Sclerogibbidae comprise but two genera, *Probethylus* Ashmead and *Sclerogibba* Riggio & T. Stefani-Perez. In his revision of the family RICHARDS (1939) reduced *Tanynotus* Cameron, *Mystrocnemis* Kieffer, *Prosclerogibba* Kieffer, *Cryptobethylus* Marshall and *Lithobiocerus* Bridwell to the synonymy of *Sclerogibba*.

Sclerogibba embiidarum (Kieffer) was the first species to be recorded (KIEFFER, 1925) as a parasite of an embiopteron. The female only is known. It was reared from *Oligotoma greeniana* Enderlein in Ceylon, and is also known from India. RICHARDS (1939) regards *S. vagabunda* (Bridwell) from Hawaii as closely allied to and perhaps the same as *S. embiidarum*. SWEZEY (1939) came to the same conclusion in regard to a specimen taken in Hawaii in 1938, pointing out that the name *vagabunda* has precedence over *embiidarum*. He also suggests it as being a possible parasite of *Oligotoma saundersii* (Westwood) (=*insularis* McLachlan) in Hawaii.

Probethylus embiopterae (Dodd) was described by DODD (1939) in the genus *Sclerogibba*. The single spur to the mid tibiae and the disposition of the ocelli, the posterior pair being separated from the eyes by almost their own distance apart, clearly places it in *Probethylus*. The female only is known. It was reared from *Oligotoma gurneyi gurneyi* Froggatt var. In Australia DODD (1939) notes "The legless larva, which was nearly full-grown when found, was attached between the prothorax and mesothorax dorsally of the Embid larva which was in the last instar and was quite active. The parasite spun a cocoon, after the manner of other Bethylids."

Probethylus callani Richards was described by RICHARDS (1939) from *P. t. trinitatis* in Trinidad, and is also known from Mexico. It is the only species of Sclerogibbid reared from an embiopteron in which both the male and female are known. Observations on the rearing of this parasite have been published (CALLAN, 1939) and may be summarized as follows. The colony of *P. t. trinitatis* from which this species was obtained comprised a few adult males and females and numerous larvae of various instars. In the laboratory some of the larvae eventually became adults, but others were observed to be parasitized. The *Probethylus* larvae were apodous and bright yellow. They were ectophagous and invariably occupied a transverse position on the dorsal surface of the thorax of the host. They were usually attached between the head and prothorax or the prothorax and mesothorax, the parasitized embiopterous larva having rather the appearance of wearing a collar. Until the Sclerogibbid larvae were about half-grown, they appeared to have little effect on the host larvae, which were fully as active as those unparasitized. Later the parasitized larvae became sluggish until finally killed by the parasite. The *Probethylus* larvae continued to feed upon their dead hosts until the body contents were consumed, and pupated near the host remains within a cocoon. Cocoons were somewhat inconspicuous in the silken web of the embiopteron due to adhering excretal pellets of the latter. The cocoon of the female was white, semitransparent and cigar-shaped, measuring 4.5 mm. by 1.0 mm., and the adult emerged by an irregular hole at one end. On emergence both sexes were very active, the winged males flying from the web while the wingless females remained within the silken tunnels.

In regard to *S. turneri*, RICHARDS (1939) suggests that there is little doubt that this species will eventually be placed in some genus other than *Sclerogibba*, but thinks that it is best left in this genus until the female is known and particularly till it is shown whether *S. rufithorax* (Cameron) is or is not the female.

Little is known of the biology of the Sclerogibbidae, but it is significant that two species of *Probethylus* and one species of *Sclerogibba* have been reared from embiopterons. It may well be that, when more is known of the host relations of the family, it will be found to be restricted to the Embioptera.

TABLE 2

Known species of Sclerogibbidae

Parasite	Sex	Host	Locality
Probethylus embiopterae (Dodd)	♀	*Oligotoma gurneyi gurneyi* Froggatt var.	Australia
P. schwarzi Ashmead	♂	Unknown	North America
P. mexicanus Richards	♂	Unknown	Mexico
P. callani Richards	♂ ♀	*Pararhagadochir trinitatis trinitatis* (Saussure)	Trinidad, Mexico
Sclerogibba embiidarum (Kieffer) = *vagabunda* (Bridwell)? = *erythrothorax* (Kieffer)?	♀	*Oligotoma greeniana* Enderlein	Ceylon, India, Burma, Hawaii
S. crassifemorata Riggio and T.Stefani-Perez = *mancinii* (Masi)?	♂ ♀	Unknown	Italy
S. africana (Kieffer)	♀	Unknown	Protuguese Guinea
S. rufithorax (Cameron) = *capensis* (Brues)?	♀	Unknown	South Africa
S. magrettii (Kieffer)	♀	Unknown	North Africa, Arabia
S. turneri Richards	♂	Unknown	South Africa

Summary

Five families of Embioptera are represented in Trinidad, British West Indies. *Clothoda urichi urichi* (Saussure) and *Pararhagadochir trinitatis trinitatis* (Saussure) are the commonest species, being found in colonies under silken webs on tree-trunks well above the ground. Other embiopterons known from Trinidad are *Oligembia armata* Ross, *Schizembia callani* Ross and the widespread pantropical species, *Oligotoma saundersii* (Westwood).

The associates of Embioptera include embiophiles, predators and parasites. The most interesting predator is a small hemipteron representing a new genus and species of Microphysidae. The parasites are Hymenoptera and comprise Scelionidae attacking the eggs and Sclerogibbidae parasitizing the larvae. *Embidobia urichi* Ashmead has been reared in Trinidad from the eggs of *C. u. urichi* and *P. t. trinitatis*. The Sclerogibbid parasites are of exceptional interest. Little is known of their biology, but it is significant that *Sclerogibba embiidarum* (Kieffer), *Probethylus callani* Richards and *P. embiopterae* (Dodd) have been recorded as parasites of embiopterons. *P. callani* has been reared in Trinidad from the larvae of *P. t. trinitatis* and is the only species in which both the male and female are known. It is not unlikely that, when more is known of the host relations of the Sclerogibbidae, it will be found that this family is restricted to the Embioptera.

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REMARQUES SUR LES MIGRATIONS CHEZ LES APHIDINAE

par
L. BONNEMAISON
Versailles, France

On admet généralement que la migration des *fundatrigeniae alatae* de la plante-hôte primaire vers les plantes-hôtes secondaires et celle des sexupares ailés des plantes hôtes secondaires vers la plante-hôte primaire résulteraient toutes les deux de la maturité des tissus des plantes.

Je me bornerai à citer des recherches poursuivies chez quelques espèces appartenant à la sous-famille des Aphidinae.

Il est à remarquer tout d'abord que le déterminisme des migrations est plus ou moins poussé suivant les espèces; chez certaines, la migration n'est que partielle (espèces à migration facultative) alors que chez d'autres, la descendance des fondatrices finit par comprendre exclusivement des pucerons ailés (espèces à migration absolue).

La première manifestation des phénomènes de migration réside en l'apparition des formes ailées; celles-ci s'observent dans la descendance directe des fondatrices ou seulement à la 2ème ou à la 3ème génération et sensiblement dans les mêmes conditions que pour les espèces monoeciques.

Le Pommier est couramment infesté par 3 aphides; deux sont monoeciques *(Aphis) Doralis pomi* de Geer, *Sappaphis (Anuraphis) devecta* Wlk, et le troisième est dioecique (*Sappaphis plantaginea* Pass). La fondatrice de *Doralis pomi* donne des *fundatrigeniae apterae* auxquelles succèdent 12 à 20 générations renfermant en mélange des pucerons aptères ou ailés; ces derniers restent sur le Pommier sur lequel ils ont effectué leur développement larvaire ou vont sur d'autres Pommiers.

D'après HILLE RIS LAMBERS, il n'apparaît dans la descendance pas des fondatrices de *S. devecta* de pucerons vivipares ailés mais seulement des aptères et la génération suivante comprend des ailés gynopares et des aptères andropares. Enfin, la fondatrice de *S. plantaginea* donne naissance uniquement à des vivipares aptères et parfois à quelques ailés: ceux-ci apparaissent dans une proportion progressivement croissante depuis la 2ème jusqu'à la 6ème générations et émigrent sur les Plantains.

Les *fundatrigeniae apterae* de *M. persicae* et de *S. plantaginea* peuvent se développer sur les plantes-hôtes secondaires; il est donc possible d'étudier l'influence de l'alimentation sur la production des *fundatrigeniae alatae*.

Dans la région parisienne, les *fundatrigeniae apterae* de la 2ème génération de *M. persicae* qui sont adultes au début du mois de mai donnent presque exclusivement naissance à des *fundatrigeniae alatae*. Si l'on prélève ces *fundatrigeniae apterae* et qu'on les élève individuellement sur des feuilles de Chou, on constate que les premiers descendants sont ailés mais que tous ceux qui naissent par la suite sont aptères. Ces pucerons aptères ont été

élevés, ainsi que leur descendance, dans les mêmes conditions; ils ont donné naissance uniquement à des aptères jusqu'à l'automne, époque à laquelle sont apparus les sexupares ailés.

On peut également obtenir un pourcentage très important et même 100% d'aptères par l'élevage en plein air de *fundatrigeniae apterae* sur de jeunes feuilles de Pêcher. Par contre, si ces *fundatrigeniae apterae* sont élevés sur des feuilles âgées de Pêcher ou encore en grand nombre sur une surface restreinte de jeunes feuilles de Pêcher ou de Chou, on obtient un pourcentage très important de Pucerons ailés.

Des résultats identiques ont été obtenus avec *Sappaphis plantaginea;* en transférant des *fundatrigeniae apterae* sur de jeunes feuilles de Pommier il a pu être maintenu sur la plante-hôte primaire des pucerons aptères jusqu'au mois de septembre.

Ces expériences montrent que la maturité des tissus végétaux et „l'effet de groupe" interviennent d'une façon très active dans la production des *fundatrigeniae alatae.*

La maturité et le dessèchement des plantes-hôtes secondaires seraient la cause principale du déclenchement de la reproduction sexuée d'après MORDWILKO (1908–1909).

MARCOVITCH (1924) a montré que la diminution de la durée du jour qui se produit en automne joue une rôle primordial dans l'apparition des sexupares.

J'ai pu obtenir des sexupares et des mâles de *M.persicae* et de *Sappaphis plantaginea* en juin ou juillet en élevant sous un éclairage naturel ou artificiel d'une durée journalière de 8 à 13 h. des *exsules apterae* sur des feuilles coupées de Chou récoltées en plein air, c'est-à-dire éclairées pendant 15.30 à 16.15 h. Ceci démontre que la lumière agit directement sur les Pucerons et non par l'intermédiaire de la photosynthèse.

D'autres facteurs que la lumière interviennent cependant. En élevant *Brevicoryne brassicae,* espèce monoecique, de manière à éviter l'effet de groupe et dans des conditions d'éclairage favorables à la production des formes sexuées, il n'apparaît pas de sexupares ailés mais seulement des sexupares aptères qui engendrent des mâles et des femelles. En opérant dans les mêmes conditions avec les espèces dioeciques *M.persicae* et *S.plantaginea,* il n'est pas possible d'empêcher l'apparition des sexupares ailés. Ceci montre qu'il existe chez ces espèces dioeciques un facteur interne particulier.

Ce facteur interne ne persiste pas indéfiniment: il peut disparaître chez *M.persicae* après un à trois ans de reproduction parthénogénétique et les sexupares ailés sont remplacés par des vivipares ailés. On a remarqué depuis bien longtemps que la reproduction sexuée de *M.persicae* ne se manifeste plus dans les régions où les hivers sont relativement doux; cela est dû à ce que les conditions climatiques hivernales permettent la reproduction parthénogénétique pendant toute la mauvaise saison ce qui entraîne la disparition du facteur interne.

L'action directe de la lumière ne peut pas être invoquée pour les pucerons radicicoles; les sexupares de *Tetraneura ulmi* apparaissent dès la seconde décade du mois d'août sur les graminées sauvages alors que celles-ci sont encore en pleine végétation.

J'ai constaté par ailleurs, qu'il n'est pas possible d'obtenir rapidement des sexuales même en plaçant la descendance des fondatrices dans les conditions de milieu (lumière, température) les plus favorables à la production des formes sexuées; à une température moyenne de 18 à 20°, les sexuales n'apparaissent, suivant les espèces, que de 52 à 85 jours après la mue imaginale de la fondatrice. Il est donc possible que les virginipares aient une tendance à donner des formes sexuées mais que cette tendance soit inhibée pendant un certain temps par un agent, peut-être d'origine hormonale, dont l'influence diminue graduellement avec le temps et les générations.

L'alimentation intervient également dans une certaine mesure. Les sexupares ailés de *M.persicae* alimentés avec des feuilles de Pêcher produisent exclusivement des femelles sexuées; ces sexupares peuvent être élevés sur des feuilles de Chou; dans ces conditions, un certain nombre d'entre eux sont capables d'engendrer des femelles sexuées, des mâles, des sexupares aptères ou ailés et enfin des virginipares aptères ou ailés. Une alimentation abondante est donc capable d'entraîner le remplacement, au moins partiel, de la reproduction sexuée par la reproduction parthénogénétique.

MORDWILKO (1907) a signalé que le cycle du Puceron radicicole *Tetraneura ulmi* diffère suivant la plante-hôte; les pucerons qui se nourrissent des racines de graminées annuelles donnent naissance à la fin de l'été à un grand nombre de sexupares ailés alors que ceux qui se trouvent sur les racines de graminées vivaces peuvent persister sur ces plantes pendant l'hiver sous la forme de virginipares aptères.

Enfin, „l'effet de groupe" augmente de façon sensible la proportion des sexupares ailés; il n'intervient que d'une manière secondaire mais entraîne une accélération de la reproduction sexuée aux dépens de la reproduction parthénogénétique.

La migration de retour, des plantes-hôtes secondaires vers la ou les plantes-hôtes primaires, est attribuée à l'impossibilité pour les sexupares ailés et les mâles de se nourrir des plantes-hôtes secondaires. Cependant, j'ai pu élever pendant l'automne des sexupares ailés et des mâles de *M.persicae* sur des feuilles de Chou et obtenir des oeufs. L'élevage de sexupares ailés et de mâles de *S.plantaginea* est beaucoup plus difficile; j'ai cependant pu faire développer et se reproduire des sexupares ailés et des femelles sur des feuilles coupées de Plantago lanceolata et obtenir des oeufs d'hiver.

Sans vouloir prétendre expliquer entièrement le déterminisme des migrations des Aphides par ces quelques expériences, il semble que l'on puisse conclure que:

1) L'apparition des formes ailées au printemps chez les espèces monoeciques et dioeciques relève pour une part des mêmes facteurs.

2) Il existe un facteur interne qui tend à la production de formes ailées et qui peut entraîner la naissance exclusive de formes ailées mais ce fac-

teur s'observe aussi bien chez les espèces monoeciques (*Drepanosiphum platanoïdes* Schrank) que chez des espèces dioeciques (*Anuraphis crataegi* Kalt). Par contre, il est possible avec certaines espèces monoeciques, d'obtenir expérimentalement le cycle complet depuis la fondatrice jusqu'à la production de l'oeuf d'hiver sans passer par l'intermédiaire d'une forme ailée, que ce soient des vivipares ailés ou des sexupares ailés ainsi que j'ai pu le réaliser avec *Brevicoryne brassicae* (1949), mais les femelles sexuées de *Myzus persicae* ne peuvent être produites que par des sexupares ailés.

3) La maturité des tissus des plantes-hôtes primaires et „l'effet de groupe" interviennent puissamment dans la production des *fundatrigeniae alatae*.

4) Le déclenchement de la reproduction sexuée est dû pour la plupart des espèces d'Aphidinae à l'action directe de la lumière mais ce facteur ne peut pas toujours être invoqué puisque les formes sexuées de quelques espèces monoeciques (*Sappaphis devecta, Aphis saliceti*) sont notées en plein été.

5) Il semble qu'il y ait, chez les espèces dioeciques, un facteur interne entraînant la production des sexupares ailés qui n'existe pas chez certaines espèces monoeciques.

6) Les migrations des Aphidinae sont beaucoup moins rigides que celles des Eriosomatidae et des Chermesidae: il semble que cela soit dû à ce que le phénomène de la migration s'est créé beaucoup plus tôt chez ces deux dernières familles que chez les Aphidinae.

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DISCUSSION

Mr. **Stroyan**: Est-ce qu'on trouve en France que les *fundatrigeniae* de *Sappaphis devecta* sont toujours ou presque toujours aptères? J'ai remarqué en Angleterre que certaines galles de la 2e génération produisent exclusivement des formes ailées, bien que HILLE RIS LAMBERS dise que dans les Pays-Bas il est rare que des galles de la 2e génération ne comprennent que des formes ailées normales. Je n'ai remarqué aucune différence importante

entre les galles qui produisent les ailées et celles qui produisent les aptères alatiformes, soit en taille, en couleur ou en nombre des pucerons qui les habitent.

Mr. **Bonnemaison**: Je n'ai pas fait d'observations suivies sur cette espèce; il semble que plusieurs espèces produisent des galles similaires. En ce qui concerne *S. devecta*, il est possible que la proportion des formes ailées de la 2e génération ne soit pas la même en Angleterre et en Hollande.

Mr. **Bernard**: L'effet de groupe est-il dû à une carence en nourriture ou à une concentration d'un corps chimique quelquonque émis par les pucerons?

Mr. **Bonnemaison**: Non, certainement pas à une carence de nourriture; il relève plutôt d'un facteur psychique.

Mr. **Kennedy**: Comment est-ce que vous constatez que l'effet de la lumière est nettement un effet direct sur les pucerons, et non pas un effet indirect à travers la plante?

Mr. **Bonnemaison**: J'ai opéré avec des feuilles coupées de chou récoltées sur des plantes cultivées en pleine air; les expériences ont été faites en juin et juillet, c'est-à-dire au moment où la durée du jour était de 15.30 h. à 16 h. Les élevages ont été réalisés au laboratoire; les pucerons étaient placés sur les feuilles coupées et exposés à une lumière naturelle ou artificielle d'une durée de 8, 10 ou 12 h; les feuilles étant changées tous les deux ou trois jours, la lumière réduite ne pouvait exercer son action sur la plante mais seulement sur les insectes.

ÜBER BIOLOGISCHE ERSCHEINUNGEN DES UNTERSCHIEDLICHEN VERHALTENS VON INSEKTEN UNTER DEM EINFLUSS BIOTISCHER UND ABIOTISCHER FAKTOREN

von

W. REICHMUTH

Celle/Hannover, Deutschland

. *Vorbemerkungen*

Die grossen Fortschritte der letzten 10 Jahre auf dem Gebiet der Be-ämpfung schädlicher und lästiger Insekten haben entomologischen Forschun-en starken Auftrieb gegeben, bei denen bisher im allgemeinen ein Überge-'icht der Systematik und Morphologie gegenüber der Ökologie und Physiolo-ie immer wieder bemerkbar wurde. So mussten bei entomologischen Arbeiten ngewandter Richtung mancherlei Grundlagen erst geschaffen werden, weil üickgriffmöglichkeiten auf erwünschte Ergebnisse fehlten. Nicht zuletzt aben die Ereignisse des vergangenen Krieges einschneidende Veranlassung adurch gegeben, dass sich der Mensch infolge tiefgreifender Veränderungen ewohnter Lebensverhältnisse vielerorts Insektenplagen zu erwehren hatte. ı diesem Zusammenhang ist es bezeichnend, dass der Kenntnisstand von en Läusen 1939 mit Beginn des Krieges auf Ergebnissen fusste, die bei nde des ersten Weltkrieges und noch kurze Zeit danach ermittelt worden aren.

Seitdem sich mit Anwendung von modernen synthetischen Insektiziden us der Gruppe der zyklischen Chlorkohlenwasserstoffe die Meldungen über ersagen der Bekämpfungsmassnahmen gegen Fliegen mehren, muss festge-tellt werden, dass über echte Resistenzerscheinungen bei diesen Tieren nd Insekten überhaupt bisher verhältnismässig wenig bekannt geworden st.

Der mit letztem Beispiel erwähnte Umstand hat unter anderem dazu ge-ihrt, dass der Begriff *Resistenz* auf entomologischem Gebiet häufig miss-rauchit wird.

In Auswahl werden einige Ergebnisse mehrjähriger Arbeiten vorgewiesen, n Ergänzungen oder Korrekturen an bisherigen Vorstellungen abzugeben. ie mögen beleuchten, dass Erklärungen für biologische Erscheinungen chwerlich unter ausschliesslicher Berücksichtigung *einer Methode* möglich ind, sondern dass die biologischen Probleme zumeist ein weites Spektrum aben, das durch mehr oder weniger verwickelte Wechselwirkungen gekenn-eichnet ist.

Biotische Faktoren

a. Alter — Als Beispiel für die Einflussnahme biotischer Faktoren auf das erhalten von Insekten sind Versuche an verschieden alten Fliegen in-ressant, die mit Hilfe eines Schwelbelages von HCH auf ihre Empfindlich-

keit untersucht wurden. Werden Stubenfliegen im Alter von 1, 2, 3, 4, 5 und 6 Tagen für die Dauer von 10' einem derartigen Schwelbelag exponiert, so weichen die Abtötungsprozentsätze je nach Alter der Fliegen stark voneinander ab. Ältere Fliegen zeigten sich dabei im allgemeinen erheblich widerstandsfähiger als die jüngeren (Abb. in 17).

b. Dichte – Einen merkbaren Einfluss auf das Verhalten der Fliegen übt auch die Dichte der Larven in einer festgesetzten Nährsubstratmenge aus. Auf 1 kg Nährsubstrat (2 : 1 Pferdekot - Quark) entwickeln sich 3000 Maden der Stubenfliege zu Vollkerfen, deren Grösse an die der Fannien erinnert, während sich 1000 Maden in gleicher Menge und Art des Nährsubstrates zu normalen Exemplaren entwickeln (17). Diese kleinen Fliegen erweisen sich zum Beispiel bei den voraufgehend erwähnten Testen auf Schwelbelägen gegenüber den normalen Formen deutlich als empfindlicher.

c. Nahrung – Es ist auch schon an Hand von Ergebnissen über Nahrungseinflüsse beschrieben worden (17), dass Fliegen, aus einem Gemisch von Schaf- und Ziegenkot im Verhältnis 1 : 1 entwickelt, bei einem 4'-Expositionstest auf DDT-Substrat mit rd. 80% definitiven Rückenlagen im Laufe von 24-48 Stunden doppelt so empfindlich sind, als Fliegen, die in einem Gemisch Pferdekot und Quark im Verhältnis 2 : 1 gezüchtet worden waren und in der gleichen Zeit bei ebenderselben Vorbehandlung rd. 40% DR ergaben.

d. Geschlecht – Ebenso konnten Feststellungen über das Verhalten der Geschlechter (13) an Hand derartiger Methoden ermittelt werden. So zeigte sich bei HCH-Schwelbelägen, dass zur Abtötung von Weibchen in der gleichen Latenzzeit wie von Männchen das 50- und teilweise Mehrfache der Normalkonzentration erforderlich war (Abb. in 17).

Eine Auswirkung dieser und noch anderer hier nicht mehr zu erwähnender Faktoren in der Praxis zeigt eine Karte (17) der geographischen Verbreitung erfolgloser Fliegenbekämpfung mit DDT- und DFDT-Präparaten im deutschen Bundesgebiet nach dem Stand im Herbst des Jahres 1949, wobei sämtliche seit 1942 voraufgegangenen Erhebungen Berücksichtigung gefunden haben. Derartige Störungen machten sich in Deutschland im Bereich des Bundesgebietes vor allem im Jahre 1948/49 bemerkbar. Im Vergleich mit einer Karte der Niederschläge im Jahresmittel fällt auf, dass die Bereiche der Wirksamkeitsausfälle sich mit den Zonen der Niederschlagshöhe von 70 cm und mehr im Jahresmittel weitgehend decken. Andere alljährlich seit 1942/43 bearbeiteten Bezirke aus Niedersachsen, am Taunus, bei Frankfurt/Main, oberhalb Mainz u.a., wo bis dahin Wirksamkeitsbeständigkeit festgestellt wurde, liegen in Niederschlagszonen mit Jahresmittel von 50 cm und weniger. Die Erklärung dieser Phänomene ist also nicht an Hand eines, sondern aus dem Wechselspiel *vieler Faktoren* zu suchen und gegeben.

3. *Abiotische Faktoren*

e. Temperatur und Feuchtigkeit – Zu den Einflüssen abiotischer Faktoren damit übergehend, soll noch am Beispiel der Laus die Einflussnahme vom

Zusammenwirken von Temperatur und Feuchtigkeit und ihrer Bedeutung für die Lausphänologie, die Epidemiologie des Fleckfiebers und die sog. Fahrenholz'sche Regel erwähnt werden. FABRICIUS (4) hat die Frage nach den Läusen der Menschenrassen aufgeworfen. MURRAY's Arbeiten (14) bilden den Ausgangspunkt für die Anschauung, dass die Farbe der Läuse der der Haare ihrer Wirte angepasst sei. Auch NUTTAL (15) führt aus, dass die Läuse im schwarzen Haar und auf Negerhaut dunkeln, während sie bei weisshäutigen und hellhaarigen Menschen hell werden. FAHRENHOLZ (6) hat sich diesen Darlegungen angeschlossen und die Frage nach dem „Wie" offengelassen. Er und spätere Autoren haben auf Grund morphologischer Differenzierungen ausserdem weittragende Schlüsse gezogen, die in der Theorie gipfeln, dass die Parasiten die Phylogenie ihrer Wirte widerspiegeln.

SIKORA hatte helle Läuse in schwarzen und dunkle Läuse in weissen Galalithkäfigen unter dem Rock gehalten. Sie glaubte feststellen zu können, dass die dunklen Tiere unter dem Einfluss ihrer Umgebung hell werden und die hellen Läuse dabei dunkeln. Es darf wohl zunächst festgestellt werden, dass bei dieser Methode die Helligkeits- und Dunkelheitswerte der Käfige, in denen sich die Läuse befanden, für die Versuchstiere kaum bei dem Tragen unter der Kleidung zur Geltung gekommen sein dürften. Die Frage nach dem „Wie" musste daher auch nach diesen Versuchen als ungeklärt oder mindestens unbefriedigend beantwortet angesehen werden. Allerdings hat auch BUXTON (2) in seinem trefflichen Buch über die Laus diesem Problem 1947 und 1950 noch nichts hinzugefügt, und die Forderung von FERRIS(7) nach ausgedehnten experimentellen Studien hat kein grosses Echo gefunden.

Werden Kleiderläuse oder Kopfläuse, die in Bestätigung der Ergebnisse älterer Autoren auch nach eigenen Untersuchungen als Biotypen einer Art *Pediculus Humanus* angesehen werden, mit Rücksicht auf ihre unterschiedlichen Pigmentierungen der Kopf-, Brust- und Hinterleibsplatten selektioniert, so lassen sich im Laufe von wenigen Generationen reine Linien züchten, die entweder gar kein Pigment bis auf das in den Augen, oder ein Maximum an Pigmentierung aufweisen. Die Abbildung (Abb. 1) zeigt Typen der sog. schwarzen und weissen Laus, die sich ebenso aus der Kopflaus wie aus der Kleiderlaus erzüchten lassen. Zu den späteren Mitteilungen WIESMANN's über die *Arnäs*-Fliege liessen sich leicht Analogien aufstellen. Es mag hier unter Hinweis auf bereits erfolgte Veröffentlichungen meiner Ergebnisse (8, 9, 11, 16 u.a.), auch durch andere Autoren, lediglich erwähnt sein, dass sich diese beiden Zuchtformen biologisch in ihren Temperatur- und Feuchtigkeitspraedilecta ebenso unterscheiden, wie in ihrer Verdauungsgeschwindigkeit, ihrem Respirationsquotienten, ihrem Speicheldrüsensekret u.a. Als besonders bedeutsam wird ferner hervorgehoben, dass die weisse Laus für Rickettsia provazecki hochempfänglich ist und daran eingeht, während bei der schwarzen Laus keine Infektionsmöglichkeit mit den Fleckfiebererregern besteht!

Die Farbunterschiede, die hier auf Grund einer Selektion im Experiment

Abb. 1. *Pediculus humanus vestimenti* L., „weisse" und „schwarze" Zuchtform. Ober- und Unterseite der Männchen und Weibchen.

erzielt worden sind, können in der Natur in verschiedenen Klimazonen der Erde beobachtet werden. Sie sind ein genetisch polyfaktoriell verankerter Indikator für Bedeutung und Gefährlichkeit der Laus als Fleckfieber-Überträger und Faktor im Seuchenzug des Fleckfiebers. Eskimos und Ituri-Pygmäen, die als Wirte von Läusen hinreichend bekannt sind, besitzen schwarze Läuse, und Fleckfieber und Rückfallfieber sind von dort nicht bekannt. Auch die Tatsache der Bollwerk-Rolle Islands gegen die Ausbreitung des Fleckfiebers dürfte sich aus der Läuse-Phänologie nunmehr ebenso erklären wie das bisher noch ohne völlig befriedigende Erklärung bemerkenswert gebliebene Phänomen, dass im ersten Weltkrieg 1914-1918 an der Westfront das Fleckfieber fehlte. In diesem Zusammenhang ist den Erzählungen der alten Weltkriegssoldaten von den „Läusen mit dem eisernen Kreuz" ein besonderes Augenmerk zu widmen (Abb. 2). Auch aus Polen (Warschau) sind Berichte bekannt, wonach die Bevölkerung lange weiss, dass die „roten" Läuse (bei denen durch das helle Chitin der blutgefüllte Darm durchscheint) die gefährlichen sind, während die schwarzen Läuse weniger gefürchtet werden. Auch die Bulgaren kennen verschieden gefährliche Läuse. Eine Vermehrung der Beispiele aus verschiedenen Erdteilen ist leicht möglich.

4. Auswirkungen und Folgerungen

Diese wenigen Andeutungen über biologische Erscheinungen des unterschiedlichen Verhaltens von Insekten unter dem Einfluss biotischer und abiotischer Faktoren mögen Veranlassung dazu geben, dass, nach den ein-

gangs mitgeteilten Ergebnissen von den Stubenfliegen, die in der Prüfungstechnik stark im Gebrauch befindliche Messmethode nach der LD 50 einer Revision unterzogen wird und die Definition der Resistenz auf autonome (spontane) Reaktionen mit dem Kennzeichen erblicher aktiver Abwehr des Organismus beschränkt bleibt, wie sie bei den Läusen eindeutig nachgewiesen werden konnte. Bei der FAHRENHOLZ'schen Regel bleibt vor Erklärung ihrer Bündigkeit festzustellen, welche und warum viele Insekten ebenso wie zum Beispiel auch Helminthen dieser Regel *nicht* folgen.

Abb. 2. Das „Eiserne Kreuz" auf dem Thorax der „schwarzen" Laus (Vergl. Abb. 1). Oberseite des „schwarzen" Weibchens und Männchens.

Nach den vorliegenden Ergebnissen und Mitteilungen ist festzustellen, dass die Wirtsspezifität eine ökologische und letzten Endes physiologische Grundlage hat. Die Läuse reagieren beispielsweise am Menschen nicht auf die Abwandlung des Wirts sondern auf die Abwandlung der Umwelt und Lebensgewohnheiten ihres Wirtes. Es konnte ermittelt werden, dass Neger, die in Deutschland verlausten, nicht schwarze, sondern wie die Einwohner selbst, „Europäerläuse" besassen.

So stehen den Schlussfolgerungen aus Beobachtungen auf morphologischer Grundlage neue und gewichtige biologische Sachverhalte gegenüber. Wenn AMSEL (1) hervorhebt,

„Überall dort, wo die Systematik der Parasiten eine hohe Spezialisierung aufzeigt, wo feinste Reaktionen auf Wirtsveränderungen aller Art stattfinden, ist die Fahrenholz'sche Regel anwendbar und sind Rückschlüsse allgemeiner Art aus ihr zulässig. Für kein Gebiet der Parasitenkunde trifft dies in so hohem Masse zu, wie für die Läuse. Sie sind in der Tat ein wahrer Gradmesser für systematische Wertigkeiten und damit für allgemeine Fragen der Stammesgeschichte und Verwandtschaft",

so kann diesen Darlegungen hier nicht gefolgt werden.

Von den Linognathiden lebt zum Beispiel *L. setosus* auf dem Hund als einzige Land-Carnivoren-Laus. Alle übrigen Vertreter ihrer Gattung finden sich auf Zweihufern wie Hausschaf, Hausziege, Gemse, Steinbock, Hausrind. Auf die Untersuchungen von MENDHEIM (12) am Rattenbandwurm (der 28 Zwischenwirte hat, von denen zwei nicht einmal Insekten sind) sei nur hingewiesen. Von den Cocciden sei in diesem Zusammenhang *Lecanium hemispäricum* Targ. herausgegriffen. Diese Schildlaus lebt in Algerien, auf den Kanarischen Inseln und in Madeira auf Cycadaceae, in Sizilien auf Oleaceae, in unseren Gewächshäusern auf Aroideae und in Dalmatien auf Ericaceae. Als ein Beispiel der Lepidopteren kann noch aus einer Reihe von vielen die Zygaene *Procris pruni* Schiff. erwähnt werden, von der eine Varietät *P. p. callunae* Spuler. in Norddeutschland ihre Raupen auf Heidekraut entwickelt, obwohl hier ebenso Schlehen vorhanden sind wie in Süddeutschland, worauf die Raupen von *P. pruni* sich ernähren, trotz dort wiederum gleichzeitigen Vorhandenseins von Calluna vulgaris. Aus einem Gesamtüberblick über der-

artige Erscheinungen kann gefolgert werden, dass für ein Lebewesen der geringste Widerstand die Richtung für Verhalten und Entwicklung bestimmt. Hinsichtlich des Kommensalismus und Parasitismus zeigt sich, dass die Lebewesen in erster Linie aus der Arbeit anderer nach ihnen gegebenen Möglichkeiten Vorteil zu gewinnen in der Lage sind, um dabei entweder nur ein Minimum oder gar keine eigene Aufbauarbeit leisten zu müssen.

Im Verhältnis zwischen Läusen und Rickettsien konnte bei Läusen eine ursprüngliche *„vitale Resistenz"* festgestellt werden, die darauf hindeutet, dass die Anfälligkeit der Läuse für Fleckfiebererreger eine Sekundärerscheinung ist, die mit den Kulturerrungenschaften des Menschen und den damit geschaffenen Biotopen für die Herausbildung weisser oder heller Läuse zusammenhängt.

Bei epidemiologischen Betrachtungen über den Seuchenzug des Fleckfiebers ist in Kenntnis weltweiter Verbreitung von *Pediculus humanus* davon auszugehen, dass es zwar ohne Läuse kein Fleckfieber gibt, dass aber die Übertragungsmöglichkeit durch Läuse erst da möglich ist, wo es diesen Tieren an der ihnen eigenen „vitalen Resistenz" fehlt. Der Grad der Fleckfiebergefahr wird somit nicht zuletzt von der Laus selbst bestimmt, die in ihrer dunklen Form ein natürliches Epidemiehindernis darstellt!

Als erworbene Eigenschaft ist ein Widerstand gegen infektiöse Krankheiten ebensowenig erblich, wie etwa einer gegen toxische abiotische Einflüsse; es sei denn, dass im Sinne einer Entwicklung durch Auslese die Widerstandsfähigeren überleben. Eine Aktivität bei solchem Widerstandswachstum ist aber nur erkennbar, wenn die Infektion oder der toxische Einfluss sehr lange anhält, d.h. auf viele Generationen einwirkt und schliesslich die Mehrzahl der Angesteckten oder Begifteten am Leben bleibt. Zu diesem Problem liefert uns in der Gegenwart gerade die Stubenfliege und ihre Bekämpfung mit den neuen Insektiziden ein grossangelegtes Experiment. Wir haben letzthin vor allem aus den Skandinavischen Ländern in zunehmendem Masse Meldungen über widerstandsfähige Formen erhalten. Bisher konnte aber noch keine echte Resistenz nachgewiesen werden, weil die Tiere unter anderen Bedingungen nach mehreren Generationen immer wieder in die Empfindlichkeit der bisher als normal angesehenen Fliegen zurückfielen. Es bleibt abzuwarten, welches Ergebnis dieses Experiment zeitigt.

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ON SUBSOCIAL BEETLES FROM THE SALT-MARSH, THEIR CARE OF PROGENY AND ADAPTATION TO SALT AND TIDE

by

Ellinor BRO LARSEN
Copenhagen, Denmark

The animals dealt with in the following pages are digging beetles belonging mainly to the genus *Bledius;* of special interest is *Bledius spectabilis* which shows a great adaptation to salt and tide and builds up dense colonies in the tidal zone in spite of a rather small number of youngs (1).

In the tidal zone and in the salt-marsh the life of terrestrial insects is governed by few, but very extreme factors. Under these conditions, an organization which sacrifices some reproductive capacity in favour of an elaborate care of the progeny will benefit the population.

All members of the genus *Bledius* take special care of their eggs, but in *Bl. spectabilis*, which lives right in the tidal zone, the care of progeny has reached a sub-social standard. The mother makes a special nest-tunnel, in which male and female stay; in the walls she digs rooms for the eggs, and the newly hatched larvae live in the nest and eat algae stored by the mother, she stays with the young, ventilates the nest and collects new food at intervals. Sometimes the parents defend the entrance of the nest against intruders, but the highly specialized family behaviour seems mainly to be a protection against the extreme physical conditions offered by the salt marsh.

Two factors seem to be of main importance for these beetles: 1) The salt content of the sand and algae-layer in which they live and on which they feed, and 2) The effect of periodical submersion by the tide.

Many of the species of *Bledius* store food reserves in their tunnels, such as *Bl. diota, Bl. taurus* and *Bl. spectabilis.* The first two species do not normally live right in the tidal zone but further inland where salt-water stagnates and consequently gives rise to extreme fluctuations in the salinity. *Bl. taurus* and *Bl. diota* often make their storage just after rain and thus avoid too high salt concentrations in the food, but *Bl. spectabilis* cannot avoid salt in the stores of algae since the tide covers the living place almost every day. It is shown that the stores have up to 4% NaCl, and at leas adults eat algae with 5-6% NaCl, but they do not store them.

It would seem to be a serious problem for these insects to eat food of s high osmotic power without the body fluid being too concentrated. It is possible to determine, by means of a method worked out by J.A.RAMSAY, the osmotic pressure in very small samples and to determine the Na-content o the samples (2, 3). By using this method we have shown that *Bl. spectabilis* exercises a powerful osmoregulation, keeping the blood as the most stable component, fluctuating about 1.2% NaCl. The digestive fluid of the foregu varies over a wider range dependent on the food given, and the anal flui

fluctuates even more, because excess of salt is excreted and water is reabsorbed here (Table 1).

Table 1

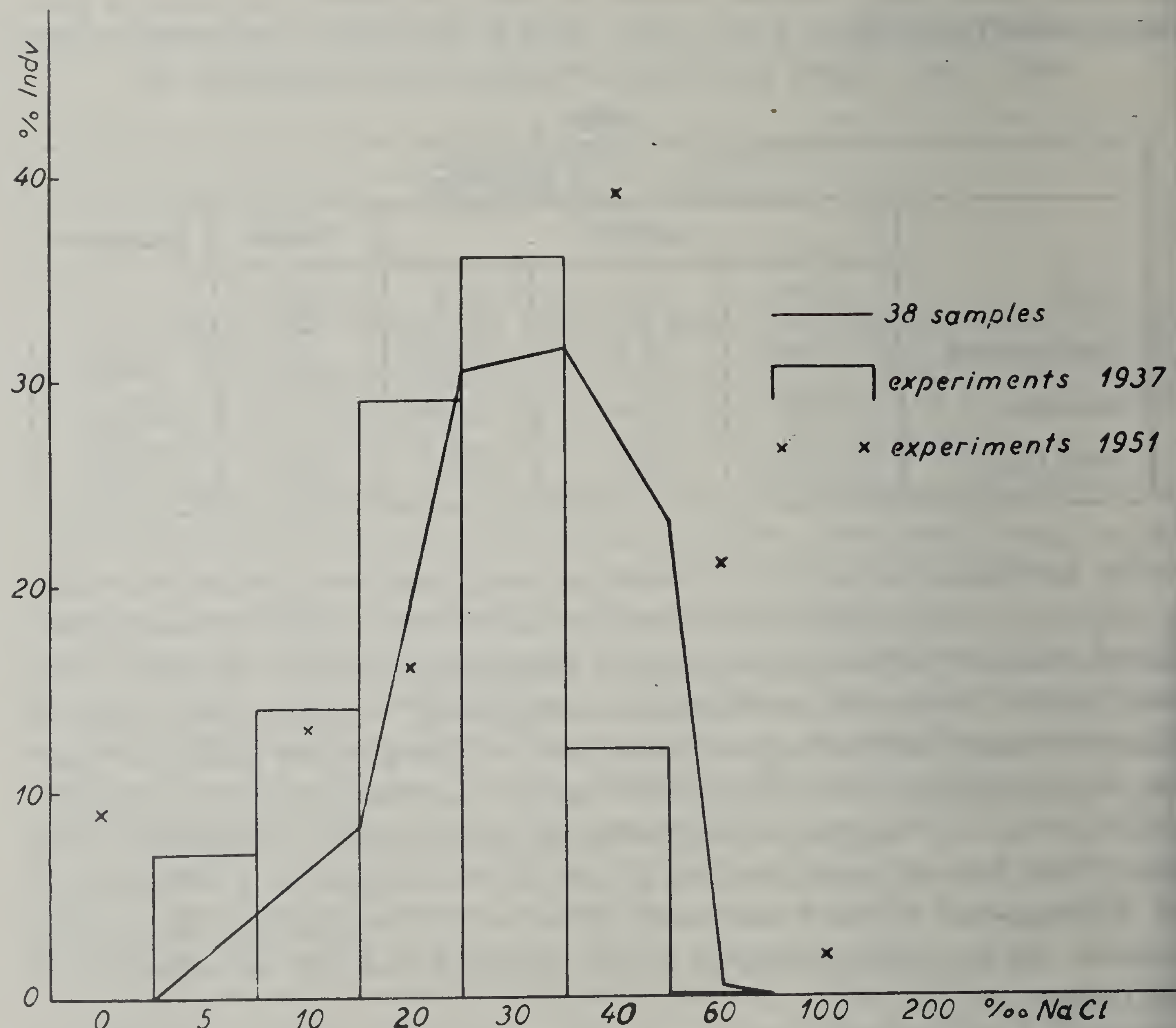
% NaCl in:					
	adults			larvae	prepupae
food	0.25	3.5	6.1	4.0	-
haemolymph	1.06	1.3	1.5	1.4	0.95
foregut	0.95	1.6	2.3	-	0.93
anal fluid	0.75	3.6	12.5	5.7	1.65

The mechanism is not fully cleared up, but if food with radioactive NaCl is supplied, blood samples show that the salt taken in with the food passes through the wall of the digestive tract immediately, and can be found in the body fluid. To keep the concentration sufficiently low here, NaCl must be excreted through the Malphigean tubes into the hind-gut from which the water can be reabsorbed. This is possible only if the hind-gut is of a different structure than the midgut, which swells up enormously in a hypotonic solution. Either the very strong muscular layer of the hind-gut or a difference in the diffusion-rate of NaCl and water in the wall of the hind-gut may be responsible for the non-swelling-up of the hind-gut and the concentration of NaCl here.

Kept in cultures the feeding activity of the animals seems to be higher at a low salinity, nevertheless in a preference-apparatus the animals will collect in places with a high salt concentration, corresponding to conditions in their favourite habitat. Fig. 1 shows a diagram on experimental data of the preference – blocks – and on the number of animals at corresponding salinity from field samples – full drawn line – (crosses represent data from later experiments). The agreement is quite obvious.

Both *Bl. spectabilis* and more often *Bl. diota* and *Bl. taurus* can nevertheless be found at rather low salinities. However, the beetles do not do well in such places. They are f. inst. more often attacked by parasites and predators than on biotopes with high salinities. Observations were made on such a rather fresh locality at Skallingen in West Jutland and a.o. an infestation of a fungus belonging to the family Laboulbiniales was most remarkable. This summer up to 40% were infested and last year the percentage was still higher (newly emerged individuals had no parasites). In the neighbouring salt localities in the same place one – only one – among hundreds was infested by these fungi.

Most Laboulbiniales are considered to be rather harmless parasites, but the fact is that many of the infested beetles get sluggish and walk around on the surface eating almost nothing – the mortality-rate in cultures is con-



siderable, especially when antennae and mouthparts are attacked –, and in the autumn of 1950 a good deal of the population did not succeed in reaching the hibernation localities.

The members of the genus *Bledius* possess specially adapted predators among the members of the genus *Dyschirius. Dysch. chalceus* and *Dysch. salinus* belong to the tidal zone and salt marsh, *Dysch. chalceus* is very rare, *Dysch. dalinus* more common, i.e. about one to 50 *Bledius* in the examined locality, but in fresh localities more species occur and they are more common, e.g. *Dysch. arenosus, D. obscurus, D. politus* and *D. impunctipennis;* in the above mentioned locality I counted 4 *Dyschirius* to 10 *Bledius.* That means that the predator pressure is higher in fresh than in salt localities.

The high salinity of the natural habitats in itself does not seem to do the animals any good, on the contrary they have adaptations in their behaviour to avoid too high salinity of the food and a physiological mechanism to get rid of the salt; but they compete better in such localities, because a good deal of the enemies (parasites and predators) thrive badly at high salinities.

This has a resemblance to the well-known fact that the success of many plants in salt marshes depends on two factors, viz. that they are able to

tolerate salt, which often means that they can get rid of the salt taken in, and the lack of competition, because other species are less tolerant of salt.

The salt marsh beetles have gone one step further being able to some extent, to find actively suitable localities giving less chance to mere selection, which of course is a matter of better economy.

The periodic often long-lasting watercover caused by the tide has many consequences, one of them is that when covered with water, the sand looses its contact with the air, and the oxygen tension decreases as a consequence of the decomposition of organic matter; the sand assumes a bluish-black colour from underoxygenated sulphuric iron-components. Lack of oxygen and a fluctuating oxygen tension create a problem for many animals, and of course the immobile stages are specially exposed; for instance the eggs of many dung-living flies (*Scatophaga, Musca autumnalis* a.o.) are provided with respiratory instruments which allow the egg to rest protected in the wet dung and to be supplied with oxygen from the free air; and the full grown larvae of the species *Musca domestica* give up their preference for an intermediate optimum temperature (4) and develop a simple thermo-negative reaction, which leads them to the margin of the fermenting dung where the oxygen supply is sufficient. The very strong photo-negative response prevents them from going further into the open. Such simple kinetic or taxic reactions to physical gradients often serve as "token"-reactions and lead the insects" to "requirements" which in other cases might involve more complicated behaviour such as is the case with *Bledius.*

Simple reactions to a gradient whatever it might be, salt, water, oxygen, light, which could lead *Bledius spectabilis* in blue sand to safe conditions concerning the oxygen supply, as far as I can see either bring the animals to the surface or into the deeper layer of the sand, and both of these solutions would be disadvantageous; the surface is too unstable and the deeper layer too soft. But in my opinion the mothers' care of the progeny and the peculiar pupatory habits of the fully grown larvae are adaptations to solve the oxygen problem.

In comparison with other species, *Bl. spectabilis* makes very wide tunnels which are ventilated by the fluctuating water level and the digging activity of the animals, the walls become oxygenated, changing from blue to grey or rusty in colour. Most of the species of *Bledius* make small isolated caves for the single eggs. If this method was also used in the blue sand localities they would very soon loose their oxygen content, but *Bl. spectabilis* keeps an exit open from the egg caves to the nest which is ventilated daily, the cave walls become white and the room well oxygenated. Further, the mother keeps the very weak first instar larvae in the nest and saves them from digging tunnels themselves which would be too narrow to allow a good ventilation.

Another critical period sets in when the full-grown larvae are going to pupate, all species of *Bledius* except *Bl. spectabilis* have isolated pupal

caves, which in blue sand localities would involve lack of oxygen for the pupae, but keeping the last, big larval tunnel and making an entrance from this to the pupal cave, the cave will show up grey and rusty during the whole period of pupation.

The entrance to the cave is rather complicated, consisting of a system of three funnels ending with a spout in the lumen of the tunnel (5). The idea in this arrangement seems to me to be, partly to establish a big air supply, but divided into smaller rooms for stabilizing, partly to function as an air-trap to prevent the air from escaping when the water comes into the larval tunnel and finally the spout makes it more difficult for predators (fly-larvae, beetle-larvae) to find the open entrance.

It may happen that the mother gets lost or the funnels break down. Then we find the sand blue and the eggs or pupae killed. Further details will be published later.

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DISCUSSION

Mr. **Théodoridès**: a. It is very interesting that Miss BRO LARSEN has noticed a noxious action of the Laboulbeniales on *Bledius*. Till now these Fungi were considered as more or less harmless. Is the species found a new one, and has it been found on several species of *Bledius*? b. Do the *Bledius* species hibernate in the same biotope as the one in which they live in spring and summer? Is *Dichirotrichus pubescens* to be found co-hibernating with *Bledius spectabilis* as it does in France (Brittany)?

Miss **Bro Larsen**: a. The species of Fungus has not yet been fully determined, most probably it will appear to be a new species. b. Almost all *Bledii* have special hibernating quarters. *Dichirotrichus pubescens* may be found together with *Bledius spectabilis*, but is more common in habitats with a little more vegetation.

Mr. **Buxton**: Did you offer in the choice chamber a choice of food of different salt contents, or of different salinity in the sand surface?

Miss **Bro Larsen**: The chamber offered a gradient of salinity in the sand of the bottom.

PROBLEME DER XENOPHOBIE UND XENOPHILIE BEI DER WIRTSWAHL PHYTOPHAGER INSEKTEN

von
Erich M. HERING
Berlin, Deutschland

Die nachfolgenden Ausführungen befassen sich mit zwei Sonderfällen der Wirtswahl monophager Insekten, denen bisher so gut wie keine Aufmerksamkeit geschenkt worden ist. Sie stellen sich heraus bei der Untersuchung der Monophagie 3. Grades (eine Insektenart lebt praktisch an allen Arten einer Pflanzengattung) und können auch bei der Oligophagie 1. Grades (eine Insektenart kann sich an zahlreichen Gattungen einer Pflanzenfamilie entwickeln) beobachtet werden. Man sieht heute in der Monophagie eine hohe Spezialisierung in der Nahrungswahl eines Insekts; doch erscheint es nicht zulässig, sie allein von der Seite des Parasiten aus zu betrachten, wie es meistens geschieht; vielmehr ist sie als Resultat eines Widerspieles zwischen Parasiten-Aggressivität und Wirtresistenz anzusehen. Mit dieser Einschränkung soll hier von einer Wirts*wahl* gesprochen werden.

Als Belege für die nachfolgend zu behandelnden Probleme werden hier vorzugsweise blattminierende Insektenlarven herangezogen. Äusserer Grund dafür ist eine über mehr als 30 Jahre sich erstreckende Zucht- und Beobachtungstätigkeit in dieser biologischen Gruppe, so dass ein umfangreiches kasuistisches Material als Basis der Betrachtungen dienen konnte. Ein mehr wesentlicher innerer Grund ist dadurch gegeben, dass die jeweils zu untersuchenden Arten meist ihr ganzes Larvenleben im Innern eines einzigen Blattes zubringen und oft nicht imstande sind, auf ein anderes oder gar auf eine andere Pflanze hinüberzuwechseln. Deshalb scheiden Fehlbeobachtungen aus, die sich sonst oft daraus ergeben, dass eine Larve vorübergehend sich auf einer anderen Pflanze befand und diese dann als „Wirt" registriert wurde. Es ist unerheblich, dass hier das Problem von der Larve auf die eiablegende Imago verschoben wird; beide stellen eine biologische Einheit dar wie Kind und Erwachsener, die Bevorzugung gewisser Substrate wird nur von einem Stadium auf das andere übertragen, was namentlich im Phänomen der „Gewöhnung" offensichtlich wird.

I. *Xenophobie*

Bei einer echten Monophagie 3. Grades werden fast wahllos praktisch alle Arten einer Pflanzengattung durch einen bestimmten Parasiten befallen, bei der Oligophagie 1. Grades praktisch alle Gattungen einer Pflanzenfamilie. Beide Formen der Nahrungswahl werden sehr häufig bei den verschiedensten Insektenordnungen (wie auch bei parasitischen Pilzen) beobachtet. Umso befremdlicher wirken gewisse Fälle, in denen die Entwicklung des Parasiten sich *nicht* vollzieht an Arten seiner Wirtgattung, die ursprünglich im

Verbreitungsgebiet des Parasiten nicht heimisch waren, sondern aus geographisch entlegenen Örtlichkeiten erst (aktiv oder passiv) durch den Menschen eingeführt worden sind. Es liegt dann eine Modifikation der Monophagie 3. Grades vor, für die der Terminus Xenophobie vorgeschlagen wird. Um eine Xenophobie handelt es sich also, wenn ein Parasit, der praktisch alle Arten einer Pflanzengattung befällt und sich an ihnen entwickeln kann, seinen Wirtskreis nicht ausdehnt auf Arten, die aus entfernt liegenden Regionen stammen. Sinngemäss kann dieser Begriff auch übertragen werden auf die Oligophagie 1. Grades, wenn Pflanzengattungen gemieden werden, die im Verbreitungsgebiet des Parasiten nicht zu Hause sind. Nachfolgende Beispiele an zentraleuropäischem Material mögen das erläutern.

1. *Lyonetia clerkella* (L.) (Lep.) erzeugt auffällige Gänge (Fig. 1) in den Blättern sehr vieler Rosaceen (Malus, Prunus etc.), ebenso häufig an Betula (Corylaceae), seltener an Salix, an Familien also, die im herkömmlichen Sinne nicht als verwandt anzusehen sind. Innerhalb der Rosaceae kommt sie besonders häufig neben Malus an Prunus avium L., P. cerasus L. und an der hartblättrigen P. mahaleb L. vor. In ihnen allen entwickelt sich die Raupe normal bis zur Verpuppung. In Jahren, in denen Massenauftreten der Art erfolgt, so dass sich oft mehrere Minengänge in einem Blatt überschneiden, findet häufig Oviposition (wohl unter Zwang durch Nahrungsmangel) an den vielfach verwilderten und eingebürgerten Prunus serotina L. und virginiana L. statt. In der überwiegenden Mehrzahl der Fälle kann sich die Raupe hier nicht normal entwickeln; man findet zahllose Gänge, in denen die junge Raupe zugrunde gegangen ist. Wenn man sich erinnert, dass die Art an der systematisch so weit entfernten Betula mit gleicher Häufigkeit sich ganz normal entwickelt, dann muss es sonderbar erscheinen, dass hier die Entwicklung so gehemmt ist, und es drängt sich der Schluss auf, dass diese Störung mit der geographischen Herkunft dieser Wirtspflanze im Zusammenhang stehen muss.

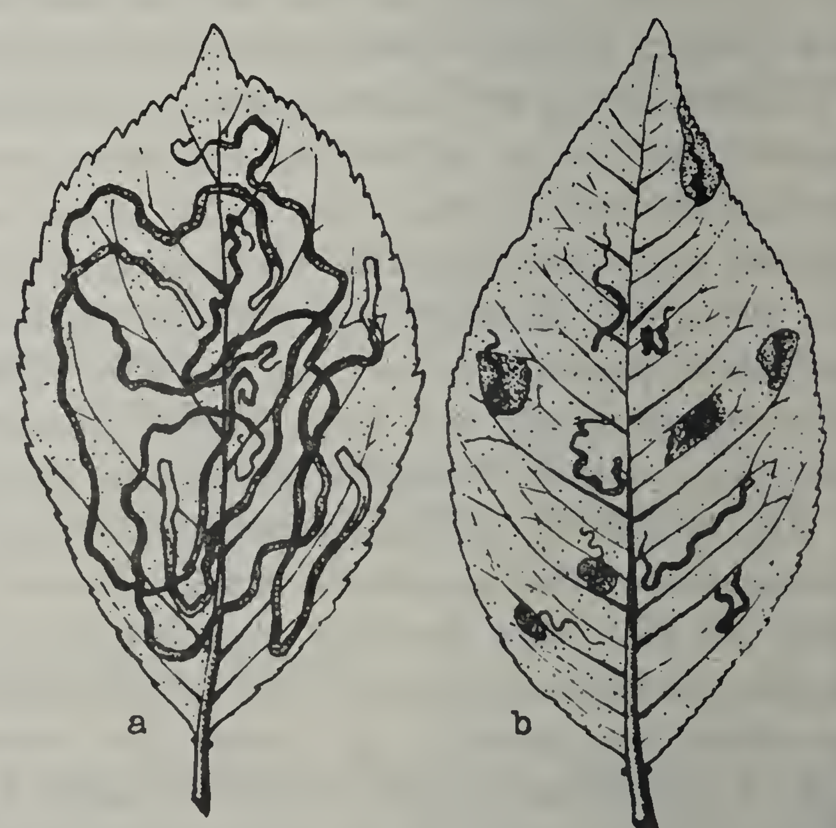

Fig. 1. Massenauftreten von *Lyonetia clerkella* L. im Blatt von a. Prunus cerasus L.; b. P. virginiana L.

2. Die Anthomyiden *Pegomyia bicolor* (Wd.) und *nigritarsis* (Ztt.) (Dipt.) sind in Vorkommen und Larvenentwicklung auf die Polygonaceae beschränkt; sie können sich in jeder hier heimischen Gattung der Familie entwickeln. Nie aber findet man eine Mine an den grossblättrigen, oft angepflanzten, ostasiatischen Polygonum (P. sacchalinense F.Schm.u.a.). Bei den häufigen

Eiablagen an den aus Asien stammenden Rheum-Arten wird nur ein kurzes Minenstück und der nachfolgende Tod der Larve konstatiert. Auch Fagopyrum, das Polygonum so nahesteht, dass früher beide vereinigt wurden, zeigt nur sehr selten Befall durch eine der beiden Arten, obgleich die Gattung bereits vor mehreren Jahrhunderten eingeführt worden ist.

3. *Anybia epilobiella* (Roem.) (Lep.) entwickelt sich überaus häufig an allen unseren Onagraceae, wird aber fast nie an der aus der Nearktis eingeführten Oenothera gefunden. Normale Entwicklung an dieser Pflanze wurde bisher nur einmal (im Botanischen Garten Berlin) beobachtet, gelingt aber leicht bei Transplantation der Raupe von Epilobium nach Oenothera.

4. Auffallend ist die fehlende Besiedelung der aus der Nearktis eingeführten Leguminose Robinia. *Liriomyza congesta* (Beck.) (Dipt.), an fast allen unseren Leguminosae vorkommend, kann sich hier nicht entwickeln, höchstens wird ein kurzes Gangstück gefressen; ebenso wurde beobachtet, dass eine *Lithocolletis* (Lep.) und eine *Coleophora* (Lep.) nach kurzer Zeit daran zugrunde gegangen waren. Diese Fälle sind besonders beweisend für die Tatsache, dass es Robinia nicht an den hypothetischen „Anlockungsstoffen" gefehlt hat; zum anderen kann nicht das Vorhandensein von toxisch wirksamen Stoffen angenommen werden, da die Pflanze in ihrer Heimat ein halbes Dutzend von Minierern ernährt. Da Robinia im Tertiär in Europa heimisch war, wird auch ein Licht auf die Zeitdauer der später zu postulierenden „Eiweiss-Entfremdung" geworfen.

5. *Ophiomyia maura* (Mg.) (Dipt.) erzeugt eine auffallende, lange Gangmine im Blatt von Solidago virga-aurea L. Nie jedoch ist sie an den eingebürgerten nearktischen S. serotina Ait. und canadensis L. zu finden, obgleich 2 anderen Minierern (*Dizygomyza posticata* (Mg.) und *Phytomyza solidaginis* Hd. (Dipt.)) dieser Übergang gelang. Das ist besonders befremdlich deshalb, weil die ökologische Valenz der Dipterenart ausreicht, um sich auch an Aster normal zu entwickeln. D. HILLE RIS LAMBERS stellte fest (i.l.), dass auch der Aphide *Dactynotus solidaginis* (Fb.) dieser Übergang nicht gelungen ist.

Wegen des geringen zur Verfügung stehenden Raumes sollen einige weitere Fälle hier nur kurz skizziert werden. 6. *Pegomyia hyoscyami* (Pz.) (Dipt.) entwickelt sich an allen unseren heimischen Solanaceae, nie dagegen an dem ursprünglich neotropischen Solanum tuberosum L., während sie eingeführte auslandische Datura befällt (H. BUHR i.l.); die „Verwandtschaftsentfremdung" vollzieht sich offenbar in den verschiedenen Wirtsgattungen nicht einheitlich. – 7. Keine der zahlreichen, an Wildgräsern häufigen und dort stark oligophagen *Elachista* (Lep.) kommt regelmässig an den Getreidegräsern vor, die bei uns nicht heimisch sind. – 8. *Caloptilia rufipennella* (Hb.), *Nepticula aceris* Frey und *speciosa* Frey (Lep.), an allen unseren Acer-Arten häufig, werden am nearktischen A. negundo L. und saccharinum L. nur ganz ausnahmsweise gefunden. – 9. *Phytomyza primulae* R.D. (Dipt.), an einheimischen Primula sehr häufig, wurde noch nicht an eingeführten Topfprimeln (P. sinensis-Gruppe) gefunden, die von der polyphagen *Liriomy-*

za strigata (Mg.) (Dipt.) oft befallen werden. – 10. *Phytomyza plantaginis* R.D. (Dipt.), an unseren Plantago-Arten häufig, meidet P. indica L., wo diese adventiv auftritt; H. BUHR (i.l.) stellte den Übergang an dieses Substrat im botanischen Garten fest, wo offenbar eine „Gewöhnung" erfolgt war. – 11. *Phytomyza digitalis* Her. (Dipt.) ist häufig an den gelbblühenden heimischen Digitalis, sehr selten an der aus Westeuropa zu offizinellen Zwecken eingeführten D. purpurea L. Schon geringe geographische Entfernung kann danach Ursache der Xenophobie sein. – 12. Besonders verdeutlicht wird Xenophobie oft in botanischen Gärten, in denen Pflanzen verschiedener Regionen dicht nebeneinander vorkommen. Im botanischen Garten Berlin hatte *Pseudodineura enslini* Her. (Hym.) fast alle Blätter von Trollius europaeus L. zerstört, T. asiaticus L. dagegen nicht angegriffen; in dem von Rostock fand BUHR (i.l.) beide befallen, dort lag offenbar bereits Gewöhnung vor. Die ökologische Valenz von *Phytomyza actaeae* Hd. (Dipt.) reicht aus, um ausser unseren Actaea auch Cimicifuga sehr stark zu befallen. Nearktische Arten im Berliner botanischen Garten zeigen den Parasiten nur sehr selten. – 13. Sogar Anteile fremdländischen „Blutes" in einer Pflanze können die Xenophobie auslösen: An Gartenerdbeeren, Hybridformen unserer Arten mit Fragaria chiloënsis (L.) Ehrh. und virginiana Duch., findet sich niemals eine der an unseren Fragaria so häufigen zahlreichen *Nepticula*-Arten, obgleich bei *N. arcuatella* H.S. und *aeneofasciella* H.S. (Lep.) die ökologische Valenz ausreicht, um normale Entwicklung auch an Potentilla zu gewährleisten.

14. Lehrreich sind parallele Xenophobien bei parasitischen Pilzen. Die nearktische Puccinia triticina Erikss. lebt als Diplont an Triticum, als Haplont an Thalictrum. JACKSON & MAINS (1921) stellten fest, dass Hauptwirte der Haplonten Thal. flavum L. und delavayi Franch. sind, Arten, die in der ursprünglichen Heimat des Weizens vorkommen, während nordamerikanische Thalictrum-Arten viel schwächer befallen wurden. – H. BUHR (1949) fand den von ihm entdeckten Protomyceten Protomyces bürenianus Buhr ausschliesslich an Galinsoga parviflora Cav., nie an der viel später eingeschleppten G. quadriradiata Ruiz & Pav. selbst dort, wo beide in gemischtem Bestande vorkamen.

Zur Erklärung der Xenophobie können vorerst nur Vermutungen ausgesprochen werden. Noch muss unentschieden bleiben, ob die Ursachen im Wirt oder im Parasiten, oder, wahrscheinlicher, in beiden zu suchen sind. Bei der überragenden Bedeutung, die das Eiweiss im Stoffumsatz der sich entwickelnden Larve spielt, lässt sich vermuten, dass die Beschaffenheit der Proteine die Annahme oder Ablehnung von möglichen Substratpflanzen bewirkt. Die Fälle, in denen sich Insekten (besonders oligophage Arten) als ausgezeichnete Botaniker in ihrer Wirtswahl erwiesen haben, sind so allgemein bekannt und so zahlreich, dass es naheliegt, auch für die Xenophobien Protein-Differenzierungen verantwortlich zu machen. FISCHER & GÄUMANN betonen diese Rolle der Proteine auch für die Wirtswahl parasitischer Pilze. So sei, vorerst ganz hypothetisch, postuliert, dass mit der geographischen Ausbreitung einer Pflanzengattung eine immer stärkere Protein-Differenzie-

rung ihrer Arten erfolgt. Da die Proteine Träger der Vererbung und damit Ausdruck der Pflanzenverwantschaft sind, muss eine „Verwandtschaft-Entfremdung" von Arten aus geographisch entfernten Regionen angenommen werden, die manchmal über die zwischen Wirts*gattungen* hinausgeht (Beispiel 5, 12, 13), die sogar die zwischen Familien übertreffen kann (cf. 1). Bei Annahme der Richtigkeit solcher Entfremdung würden sich sogar Rückschlüsse auf die Zeit ergeben, während der sie eingetreten ist, die zwischen geologischen Zeiträumen (Robinia) und Jahrzehnten (Galinsoga) schwanken kann.

Gegen die so postulierte Verwandtschaftsentfremdung können gewichtige Gegenargumente vorgebracht werden. Das oberflächlichste ist der Hinweis darauf, dass bei anderen Parasiten andere Verhältnisse zu beobachten sind. Hier gilt, was FISCHER & GÄUMANN (1929) über die Deutung der Wirtswahl allgemein sagen: „... dürfen wir bei Besprechung der vorliegenden Frage stets nur den Wirtskreis eines einzigen Parasiten fur sich abgeschlossen ins Auge fassen". Allzu leicht macht man es sich auch mit dem häufigen Einwand, dass der Parasit sich bei der Wirtswahl nicht durch das für ihn so wichtige Eiweiss, sondern durch ± hypothetische „Anlockungsstoffe" leiten lasse. Da werden sogenannte Glucoside und Alkaloide, Gerbstoffe, aetherische Öle etc. verantwortlich gemacht. Schon FISCHER & GÄUMANN haben das für pilzliche Parasiten abgelehnt, und bei phytophagen Insekten wird es nicht anders sein. Beispiel 1, 2, 4 demonstrierten ja auch deutlich, dass Anlockung erfolgt war und trotzdem Larvenentwicklung nicht möglich war. Dass toxisch wirkende Beistoffe die Entwicklung unmöglich machen, muss auch nach Beispiel 3, 4 ausgeschlossen werden. Es können auch blattanatomische Verschiedenheiten für Ablehnung oder Entwicklungsstörung geltend gemacht werden; solche beziehen sich aber meist auf Epiderm oder Vascularsystem und betreffen nicht das Mesophyll, die vorwiegende Nahrung der Minierer. Auch Biotop-Verschiedenheiten scheiden als massgeblich aus, da meistens angenommener und abgelehnter Wirt bei uns im gleichen Biotop vorkommen, oft miteinander wachsen; das gilt namentlich für die in botanischen Gärten zu beobachtenden Xenophobien.

Modifikation der Xenophobien erfolgt in erster Linie durch das noch nicht zu analysierende Phänomen der „Gewöhnung", das bei ihnen wie auch sonst bei Monophagie und Oligophagie eine besondere Rolle spielt. Auch bei Massenauftreten werden Xenophobien „verdrängt". *Phytagromyza lonicerae* R.D. (Dipt.) ist meist sehr häufig und wird dann an fast allen eingeführten Lonicera angetroffen. In Jahren, in denen sie selten ist, kommt sie vorzugsweise an unseren heimischen Arten L. xylosteum L. und periclymenum L. vor. Endlich ist daran zu denken, dass die Besiedelung des zuerst abgelehnten Wirts auf dem Weg über Hybriden mit einheimischen Arten erfolgen kann. W. PETERSEN (1930) hat diesem Wege zur Erweiterung des Wirtskreises ein besonderes Gewicht beigelegt. Bisher konnte allerdings eine Verdrängung von Xenophobien so noch nicht beobachtet werden.

Eingehende Untersuchung der Xenophobien, möglichst in Zusammenarbeit von Entomologen, Mycologen und Phytochemikern, sind erwünscht, damit die

wahren Ursachen dieser Erscheinung ermittelt werden können. Sorgfältige Registrierung aller beobachteten Fälle ist wichtig, da unter dem Einflusse der „Gewöhnung" die Möglichkeiten zur Beobachtung in absehbarer Zeit verschwinden können.

II. Xenophilie

Viel seltener wird ein dem vorbesprochenen entgegengesetztes Phänomen beobachtet. Es handelt sich bei der als Xenophilie zu bezeichnenden Erscheinung um die Tatsache, dass eine bestimmte Insektenart eine auffällige Bevorzugung einer aus geographisch entlegenen Gebieten eingeführten Wirtspflanze gegenüber den ursprünglichen an den Tag legt. Solche Xenophilie lässt sich namentlich bei *Liriomyza impatientis* Bri. (Dipt.) beobachten, die früher in stets nur relativ geringer Zahl an der indigenen Impatiens noli-tangere L. bei uns zu finden war. Jetzt ist sie zu einer der häufigsten Arten an der aus Ostasien eingeführten und fast überall eingebürgerten I. parviflora DC. geworden. Auffällig ist der dabei vorgenommene Biotop-Wechsel: von sehr schattigen und feuchten Stellen ist die Art auch an sehr trockene und sonnige übergegangen. Gegenüber hohen Garten-Balsaminen (I. roylei Wlp. etc.) hat die Fliege ihre Xenophobie aufrecht erhalten, und nur, wenn solche an sehr schattigen, feuchten Orten „verwildert" sind, kann man einen Massenbefall durch die *Lyriomyza* beobachten. Der Apfelbaum (Malus silvestris Mill.) ist in Nordamerika nicht heimisch, ernährt dort aber eine ganze Anzahl ihm eigentümlicher Minierarten (Lep., Col.), bei denen gelegentlich auch Massenauftreten beobachtet wird. Doch ist anzunehmen, dass diese (nicht in Europa vorkommenden) Arten ursprünglich auf dort indigenen Malus-Arten vorkamen und nur noch nicht an ihnen beobachtet wurden. Die zentraleuropäische *Liriomyza buhriana* Her. (Dipt.) wurde ausschliesslich an den aus Nordamerika stammenden Verbena „hybrida" gefunden, niemals an der einheimischen V. officinalis L. Besonders auffällig ist, dass *Pieris brassicae* (L.) auf den Canaren in seiner subsp. *cheiranthi* Hb. (Lep.) als Raupe ausschliesslich am dort eingeführten Tropaeolum frisst, während die Nominatsubspecies vorwiegend an Cruciferen lebt. Beide Wirte gehören verwandtschaftlich weit getrennten Familien an.

Es wird schwer sein, für die seltener zu beobachtenden Fälle von Xenophilie eine zureichende Erklärung zu finden. Sie stellen eine Besiedelung von Lücken in der Lebensraum-Ausnutzung dar, die wohl manchmal für das Weiterbestehen der betreffenden Parasitenart von Wichtigkeit sein mögen. Man findet sie deshalb auch besonders bei den als „Kulturfolger" zu bezeichnenden Insektenarten. Dass auch hier eine Eiweissveränderung etwa unter dem Einfluss der besonderen Bedingungen der anderen geographischen Region erfolgt ist, wie sie für die Entstehung der Xenophobien als massgeblich angesehen wurde, ist wohl nicht anzunehmen. So scheint es, als ob diese beiden Sonderfälle der Monophagie und Oligophagie auf ganz verschiedene Ursachen zurückgeführt werden müssen.

Da es sich bei den geschilderten Phänomenen der Xenophobie und Xenophilie um Probleme des Parasitismus überhaupt handelt, werden die geschilderten Eigentümlichkeiten nicht auf Blattminierer beschränkt sein, sondern sich auch bei jeder anderen biologischen oder taxonomischen Gruppe ebenso ausgeprägt vorfinden, wenn man erst gelernt hat, auf sie zu achten. Wie die Erscheinungen der Wirtswahl der Insekten ihre Parallelen bei den parasitären Pilzen haben, lassen sich ähnliche Erscheinungen wie die berichteten auch dort vermuten. Jeder Entomologe wird aus seinem speziellen Untersuchungsgebiet weitere Beispiele den hier gebrachten hinzufügen können, und man wird berechtigt sein, in Xenophobie und Xenophilie Erscheinungsformen des Parasitismus überhaupt zu sehen.

DISCUSSION

Mr. **Lorkovic**: Ich glaube nicht dass es sich um Unterschiede der Proteinen als solche handeln wird, da so grosse Unterschiede im Proteinbau wohl auch morphologische und physiologische Unterschiede der Pflanzen hervorrufen müssten. Eher wird es sich vielleicht um prostetische Gruppen der Eiweisse handeln, die etwa wie die Antigene schädlich auf die Larven wirken könnten.

Mr. **Rivnay**: When *Icerya purchasi* feeds on certain plants it may be and is attacked by *Novius cardinalis* but when it feeds on other plants one can not induce *Novius* to attack *Icerya*. Do you happen to be able to offer an explanation for this phenomenon?

Mr. **Hering**: No, I do not know how to explain this phenomenon.

Mr. **Handschin**: Ich möchte auf Xenophilie bei *Philosamia cynthia* hinweisen, die in Ascona sogar auf Schilf überging, wobei die natürliche Nährung zur Verfügung stand. Oder auf die Anwesenheit von *Ernestia* in Gegenden wo die Nonne oder der Schwammspinner nicht vorhanden sind.

ZOOCECIDIA: THE NEED FOR CORRELATED STUDY

by

Donald LEATHERDALE
Old Woodstock, Great Britain

It is generally agreed that plant galls caused by insects (i.e. zoocedidia) are of minor or of no economic importance, with a few exceptions. For example, an oak tree may be burdened with a host of the galls of *Andricus kollari* Htg. and yet its vitality remains unimpaired. The only damage in such a case would appear to be a retardation of longitudinal growth, GILLANDERS (1908) even suggesting that galling by Cynipids may be the reason why the oak is seldom a straight pole tree. Dr. BARNES, in his recent series of volumes on the Cecidomyidae, has limited himself to species of economic importance (1946 - 1951), but many of those considered by him are of minor significance. A few Eriophyid galls, such as *Eriophyes ribis* (Westw.) Nal., assume the position of serious pests (MASSEE 1946), while there are others of potential economic consideration (LEATHERDALE 1950), but the great majority of mite galls may be dismissed economically. For this reason, the study of zoocedidia has been neglected in professional entomological circles.

The modern trend towards specialisation is another obstacle in the path of research on plant galls, for their study is a composite subject. It embraces not only various branches of entomology, but much of botany, plant pathology, and something (it should be much more) of biochemistry.

Galls have been the subject of considerable speculation from times before the birth of Christ. Their unusual and frequently bizarre forms have occasioned idle interest, while not a few have concerned themselves with the causes of their occurrence. Classical authors (as, for example, THEOPHRASTUS in HORT's translation 1916) were cognizant of galls in their medicinal and dyeing and tanning usages, but until the late fifteenth century it was thought that such galls were caused entirely by the unaided plant, the insects within originating by spontaneous generation. Marcello MALPIGHI was one of the first to deviate from this view, and his theory is demonstrated in the following translated extract from his "De Gallis" (1686):

"The liquid arising from the ovipositor is highly active and fermentative, and when injected, this excites a new fermentation or internal motion within the delicate growing particles of the plant" (BRUES 1946).

This view may be favourably compared with that given over two hundred years later by a plant pathologist of standing:

"... the irritation set up suffices to induce a flow of food materials to the stimulated spot, and the overfed cells multiply and form the gall." (WARD 1892)

The history of contributions to the literature is of no concern in this paper, and is admirably covered by BOHNER (1933 - 35). More to our point is a

humble consideration of a modern statement, by the late Dr. A.D.IMMS (1947):

"All that can be said is that the galls are produced as the result of the reactions of the cambium and other actively dividing cells of the plant, in response to a stimulus induced by the presence of the larva."

The anatomy of zoocedidia is an aspect of the subject which has been investigated only during the past sixty years. It is a purely botanical approach, and can do much to establish some order into our picture of the plant's response to the insect stimulus. Important contributions in this field have been made by BEIJERINCK (1882), COOK (1902), COSENS (1912), HOUARD (1906), KOSTOFF & KENDALL (1929), KUSTER (1911), SAKSENA (1942, 1944), and WELLS (1916), while many others have described the histology of individual galls. Nevertheless, the structure and development of many galls yet remain to be recorded, some of them even being of common and widespread occurrence. This is a field of enquiry in which much could be done by the amateur. The more complex galls of the Cynipids, in which the plant usually establishes an individual vascular system, require much further work, particularly with regard to their development. It is suggested that the use of specially adapted radiological methods are superior to normal histological techniques in this connection, although in recording the internal development of zoocedidia they have as yet been little used (LEATHERDALE 1951 a, b).

Another aspect of the study of plant galls to which spasmodic attention is directed is the preparation of distribution lists. Some local natural history societies issue annual lists giving names of unusual species encountered and making mention of fluctuations which are themselves of immediate interest to the ecologist; the value of such lists is perhaps only apparent when statistically summarised for longer periods. A further series of lists are those prepared as check lists for given areas, exemplified by BURKILL's „British gall mites" (1930), which are of considerable value to the student. Finally, we have works of considerable magnitude for the identification of the galls of various geographical or political entities. From the number of these which has been published in recent years, it is to be hoped that a greater interest is shown than would appear to be the case at first sight. Apart from HOUARD's classic works, there are FELT's popular guide to the North American species (1940), HENRIKSEN's posthumous notes on the Danish zoocecidia (1944), MIMEUR's on those of Morocco (1949), MANI's valuable work relating to India (1948), and the admirably illustrated account by ALTA & DOCTERS VAN LEEUWEN (1946) of the galls of this country whose guests we are today. It is a matter for regret that no such volume is available for the plant galls of Great Britain, SWANTON's book (1912) being out of date and very difficult to obtain.

Apart from these aspects of plant galls, and apart from the purely entom-

ological work on the taxonomy and structure of the gall-causing insects, there is little current literature on the factors to be considered responsible for the causation and growth of galls; little, in other words, to add to the remark of IMMS already quoted, and that not very in advance of knowledge in the fifteenth century.

It has long been the fashion to consider that zoocedidia and galls caused by fungi (phytocecidia) are two entirely separate types of vegetable response. There are, indeed, great dissimilarities, the phytocecidia being almost always composed of undifferentiated tissues showing none of the organisation of the higher zoocecidia. But it is now being felt, as COTTE suggested in 1911, that due to our knowledge of the phytohormones (WENT & THIMANN 1937), BEIJERINCK's ideas (1888, 1897) on the presence of "growth-enzymes" in insect galls (*Nematus capreae* on Salix) are perhaps in the direct approach to the problem. BOYSEN JENSEN (1948) maintains that a special gall-forming substance does not exist, nor does he expect phytohormones to be found in zoocecidia (personal communication, 1949), but his experiments with the larvae of *Mikiola fagi* indicate that they secrete substances capable of causing embryonic growth, cell division, and cell elongation in the host plant.

This approach is therefore worthy of much further study, and should be coupled with the purely biochemical investigations on organiser phenomena suggested by Joseph NEEDHAM (1942). In view of the fact that many gall-causing Diptera and Hymenoptera are more readily identified by their galls than by their own morphological characteristics, it seems obvious that substances producing particular morphogenetic reactions on the meristematic plant tissues must in the course of time be isolated. Various aspects of plant physiology are also of direct bearing upon the resolution of the gall-forming problem, apart from the question of phytohormones. For example, the red coloration observed in many species of gall is not a normal plant pigment, and may have a connection with growth dependent upon carbohydrate synthesis. Other lines of investigation concern host plant selection, the balance of gall communities of inquilines and parasites, and transplantation experiments.

It is thus obvious that the study of zoocecidia, and especially of their causes, involves many specialised subjects, some of which are beyond the normal equipment and training of the entomologist and the botanist. Often it is found that biochemical aspects of the problem appear in published work which has no direct bearing upon the subject, yet such material may be of the greatest interest to the cecidologist. It is to be hoped that the scientific world may produce its voluminous findings in more easily identifiable channels, and that all journals devote some space to reviews and contents lists of other publications, for on this all-embracing subject even so useful a tool as "Biological Abstracts" is of little avail.

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DISCUSSION

Mr. Cameron: In the Southern Sudan I have observed Cecidomyid galls on

the leaves, petioles and stems of aubergine. Is it unusual that several parts of the host plant should be attacked by the same insect?

Mr. Leatherdale: This is not unusual in Cecidomyidae.

Mr. Stroyan: Aphids appear to offer good material for investigating differences of reaction of primary and secondary hosts, since in this case feeding is comparable in both mature and immature stages and one single individual may therefore feed when immature on one host, causing a galling response and remove when mature to a second host, where its entirely comparable activities produce no such response.

Mr. Leatherdale: I agree that the use of such aphids would be a good starting point for such experiments.

Mr. Varley: Are any cecidomyid galls closely co-adapted to the requirements of the insect, such as in Trypetid and Cynipid galls?

Mr. Leatherdale: None form their own vascular system.

Mr. Wolcott: Are galls more abundant in the temperate zone than in the tropics?

Mr. Leatherdale: No, although their distribution would appear to be more diverse in proportion to the plant species available.

Mr. Kennedy: Have you any further comment to make on the remarkable fact that galls are generally unimportant economically? This suggest the plants suffer extraordinarily little.

Mr. Leatherdale: I have no special comment to make on this effect but I agree that it is remarkable.

ANTENNOPSIS GALLICA, A NEW PARASITE ON TERMITES

by
Harro H.R.BUCHLI
Paris, France

In July 1949 I went to La Rochelle, a town on the Atlantic coast of France, in order to study the manifold damage caused there by termites.

Though belonging to the genus *Reticulitermes*, the colonies found in this region are not of the species *Reticulitermes lucifugus*, which is common throughout Southern France. The first to differenciate between the common *Lucifugus* and the local species of La Rochelle and Saintonge, which he called therefore "*Le Termite de Saintonge*", was A. DE QUATREFAGE in 1853. The term *Reticulitermes* de Saintonge is still in use, as a thorough morphological study and specification has not yet been made.

From La Rochelle I brought a big colony back to our laboratories in Paris. In order to study the biology and caste determination of these termites the colony was used for the foundation of small societies, kept in special breeding tubes, designed by Prof. P.P.GRASSE.

Soon after the foundation of these experimental colonies I observed, that in several of them dark brown, unusual bristles began to appear on the integument of the termites. These bristles became more numerous every week until almost every animal of the colony, irrespective of the cast, was entirely covered with them, and died.

Microscopic examination revealed, that each bristle is a parasitic fungus, resembling a conidiophore. Each fungus consists of three parts: a foot and two pedicels with a germ producing head on top of each.

The footpart which could be called a haustorium, but of a morphologically and organically new type, consists of four cells forming an ellipsoid. It has a flat basal surface, by which the upright fungus is strongly attached to the chitin of the animal. It measures 21µ to 26µ in length and 8µ to 9µ in width. It seems to develop from a colourless germ by cell division. Only when the haustorium has its final shape, do its cell walls become dark brown and thus visible.

Out of the two middle cells of this foot capsule grow two separate pedicels. They consist of a single file of cylindrical cells of 4µ to 5µ in diameter. The thickness of the walls, their pigmentation and the height of the cells diminish towards the top, where cell division and growth take place. Normally a fully grown pedicel is made of 24 to 28 cells.

On its top a head is developed, at the beginning consisting of a single, ovoid, bulb-like cell, and later of 10 to 18 superposed cylindrical, dark brown cells, larger than those of the pedicel, with a diameter of 8µ to 15µ. The whole head can reach a length of 50µ. Each of its cells is a germ, but we do not know whether to call it spore or conidia, as the life cycle of the fungus is still unknown.

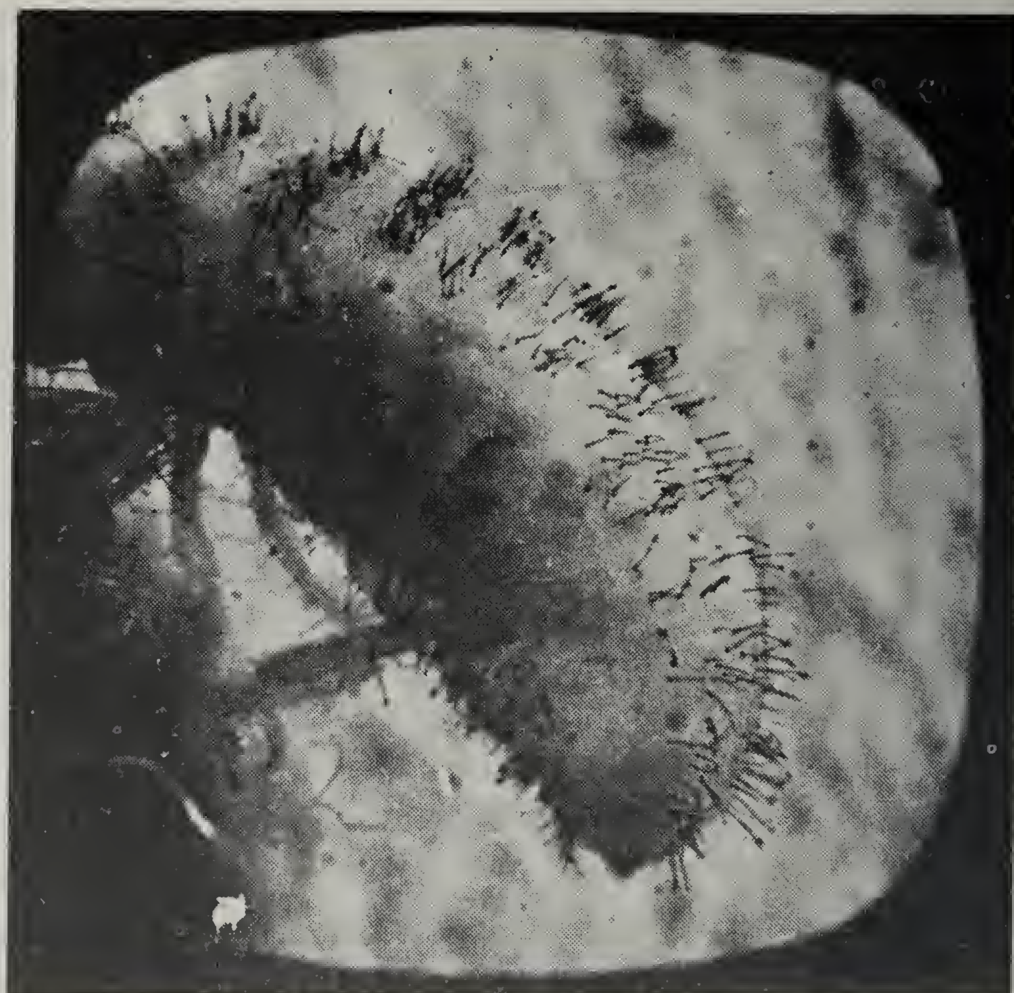

Fig. 1. Abdomen of worker of *Reticulitermes*: The tergites and sternites are covered with a fine growth of the parasitic fungi.

Fig. 2. Antennopsis growing on the femur of a nymph. At the beginning the head consists of a single ovoid cell. Cell-division takes place at the top of the pedicel where the cells always have thin uncoloured cell walls.

Fig. 3. Ripe heads of Antennopsis gallica with the cylindrical germ cells.

The many microscopical preparations which I made of animals attacked by this new disease, revealed no hyphi and no histological alterations in the body of the termite. Thus the fungus seems to be an ectoparasite.

It grows generally on the rigid parts of the integument with an exocuticle, such as the head capsule, the tergites and sternites, and is very rarely found on the flexible endocuticle between the segments and on the pleural membranes. As the legs, antennae and the mouth parts are more exposed to friction, they carry less fungi than the body, where they often form a continuous fine turf.

Before loosing all attacked and slowly dying colonies, I made several successful experiments of infection of healthy colonies.

With these results I went to Prof. R.HEIM, the well-known Mycologist and Director of the Jardin des Plantes in Paris, for identification of the fungus. He examined it and discovered it to be an entirely new kind, belonging to the Hyphomycetes. He gave it the name of **Antennopsis gallica** Heim and Buchli of the new genus **Antennopsis** Heim.

In the "Comptes rendus de l'Académie des Sciences" we published in January 1951 a preliminary description of its morphology together with my observations of its development and effect on the termites.

We do not yet know the entire life cycle of the fungus and what happens to the germs of the parasite, whether and where to look for a second host.

My first assumption was, that the germs of the ripe fungus get back directly either onto the cuticle of the same animal, or by touch of two insects or

even indirectly on the integument of a new termite becoming there a parasite again.

Several observations support this hypothesis of development. Hence the different means of infection of healthy colonies. I succeeded in infecting healthy societies with Antennopsis:

a) By putting several infected termites into a new colony. In order to prevent the intruders from being killed, I put the colony afterwards for several days into a refrigerator at 10° C, a temperature at which the insects are much less energetic. When the colony is accustomed to the introduced, infested animals, we can put it back into the incubator. Within a week already we can see the fungi developing on the healthy termites of the new colony. Thus direct infection by contact from one animal to another seems to be possible. But these experiments have shown, that such a method is rather slow and uncertain. Because the germ production is not very high the fungus spreads very slowly, and the risk of the introduced termites being killed cannot be banned entirely.

b) Infection can also be obtained, if we take a piece of wood and some building material out of a severely attacked colony and put it into a healthy one.

c) By far the easiest and most certain means of infection is to empty the breeding tube of its infected inhabitants, taking care not to destroy the existing galeries and chambers, which the diseased colony had made and in which it lived. If we introduce into this breeding tube a new colony, it will soon be attacked by Antennopsis. It must take up germs indirectly from the walls of galeries and chambers, through which the infected animals, covered with fungi have passed before.

The first and most seriously diseased castes of a colony are always those which work and move the least, so the reproductive caste (the royal imaginal couple and the neotenic kings and queens), then the soldiers and the young larvae. The least and last infected are generally the old workers of the sixth to ninth instar. It seems that their activity is an impediment for the development of the parasite. Even the larvae of the first instar, which lasts only 7 to 9 days at a temperature of 26° C, can be infested and are the first to perish in a colony attacked by Antennopsis. This shows how quickly the fungi develop, once the germs have found their way onto the cuticle.

The effect of the parasite on the colony is manifold.

Severely diseased termites seem to weaken considerably.

The moulting becomes very difficult.

When shedding their skin, most effected animals are injured by the workers which assist the procedure and which eat all damaged termites. In diseased colonies we rarely find larvae, though eggs are produced. This also has its cause in moulting difficulties. The larvae of the first and second instar are very tender and when, because of the parasite, their skin does not come off properly, they die of the injuries and are eaten.

After having produced germs, the heads of the fungi begin to secret a sticky, mucous matter, with which the termites are then covered. This is a

great hindrance to their free movement. The antennae stick to the head or the legs or block the mouthparts, which themselves can get stuck to one another. The legs get entangled. The termites are covered with dirt particles glued onto them. We can see animals dragging along young and often dead larvae or eggs, which have got stuck on their body. Because of the parasite and its stickyness the necessary licking on one another's bodies, the feeding of the royal couple, the soldiers and larvae becomes very difficult or impossible for the workers.

Small colonies of less than 400 inhabitants die generally within 6 to 9 months after the first infection, whereas under the same breeding conditions normal, healthy societies can live and increase their population for years. The more numerous a population is, the less it is affected by the parasite. During recent research in La Rochelle I found, that a great many colonies, often having far more than a hundred thousand inhabitants and covering a wide area of ground, trees and houses, are attacked by Antennopsis. But the parasite remains in the colony without causing much harm. Rarely are more than 20% of all animals diseased, and the diseased carry but few fungi. The infection seems to increase a little during the winter months, when there is less activity. But huge colonies cover such a wide area of ground and wood, that a serious infection of the whole is difficult. The animals are so numerous and active and their reproduction is so big, that the spreading of the fungi seems too slow to become efficient.

In one situation however, Antennopsis gallica has a destructive effect in natural colonies. I observed that a certain percentage of the young imaginal alates, at the time of their swarming, carry some fungi. After the swarming they break their wings off, and look for a partner with which to found a new colony. When the nuptial chamber is built, and the first eggs are laid, the young king and queen remain quietly in the chamber for the first month, awaiting the hatching of the larvae. During that month of relative inactivity the parasite can infect the partner and develop enormously. When the larvae appear, they are also attacked and die again, mostly during the moulting. Incipient, diseased colonies have almost no chance to survival.

But I found an interesting exception. About nine months after their foundation two young colonies possessed in the first case 1 and in the second case 2 infected workers,which had developed in spite of the parasite attack. At the same age a normal colony has 20 to 35 workers and 2 soldiers. Four months later the workers in these two diseased colonies were entirely free of fungi. Only the king and queen, which do not moult anymore, were covered with old dry parasites, resembling a coat of long hairs. All germ- and mucus-production had finished and finally the colony began to develop normally.

I also succeeded in infecting *Reticulitermes Lucifugus* R. and *Calotermes flavicollis* F. with the new disease. The effect of the parasite on these two species seems to be the same.

All these observations led naturally to the idea of testing Antennopsis gallica as a means of termite control. But as we have seen, the natural ways

of infection are too slow for huge colonies. Prof. R.HEIM is now trying to find a method of cultivation of the fungus. If this is possible and great quantities of germs can be harvested and be pumped in powder form into a colony, Antennopsis might prove to be a means of control of these pests.

DISCUSSION

Mr. **Lieftinck**: Has Prof. HEIM already expressed any opinion about the methods of nutrition by which Antennopsis can maintain itself on the insect?

Mr. **Buchli**: Microscopical examination has not yet been pushed far enough to know whether there is a direct communication between the parasite and the tissues of the host. It seems, however, that a fungus cannot live of chitin only.

AN ELECTRICAL HYGROMETER SUITABLE FOR MICROCLIMATIC MEASUREMENTS

by

E.B.EDNEY

Birmingham, Great Britain

The ideal hygrometer for microclimatic work would be very small, sensitive and accurate over the whole range of the humidity scale, able to withstand exposure to saturated atmospheres, capable of giving a continuous record at a distance, having no effect upon the microclimate and, finally, cheap and easy to manufacture. Such a paragon of an instrument does not, and probably never will, exist, but there have been useful advances during the last decade, and each advance brings the possibility of widening and refining our rather scanty knowledge of microclimatology.

SOLOMON (1945) described a technique for measuring the humidity in small spaces by using pieces of pure cotton fibre paper, impregnated with cobalt thiocyanate, a salt which changes colour from blue to red as the humidity increases. By comparison with standard colours the author obtained an accuracy of 2% R.H. over medium ranges, and 5% R.H. at high or low humidities. The only serious objection to the method is that the humidity cannot be read at a distance, neither can it be recorded.

Another useful method is due to KØIE (1948) who used the fact that glass wool absorbs water vapour, and therefore alters its surface resistivity, to an extent dependent upon relative humidity. Instruments based on this principle can be made as small as 40 x 6 mm., and with suitable apparatus humidity can be recorded at a distance. There appears to be little objection to this hygrometer in theory (except possibly its rather large size for some types of work, and the fact that resistances of a megohm or more are encountered). In practice however, the writer has found the design inconvenient in so far as the glass wool fibres are on the outside of a glass tube, and are therefore liable to be damaged.

The "Gregory" hygrometer, which is manufactured industrially by Messrs. NEGRETTI & ZAMBRA, is similar in essentials to that of KØIE, and is based on the variation in resistivity of glass wool yarn impregnated with a hygroscopic salt. The hygrometer to be described derives from the last two methods: it resembles the Gregory hygrometer closely, but is considerably smaller than the standard models. It is approximately the size of a full grown *Oniscus.*

The electrodes of the element (fig. 1) are short pieces of platinum-clad nickel-iron wire. A pair of these is mounted in perspex end-pieces, and each is connected by flexible insulated copper wire to the measuring instrument. A spiral of continuous thread glass-fibre yarn is wound round the two electrodes and impregnated with a weak solution of calcium chloride. The elec-

trodes and glass-fibre filaments are protected by four thin rods of non-corrosive wire, and the overall dimensions of the elements are then 10 x 6 x 6 mm. When used in the field the element may be further protected by a small wire-gauze envelope.

The measuring (or recording) instrument consists essentially of a micro-ammeter. It is necessary to use alternating current to avoid polarization of the element, and this is provided through a vibrator from a 12 volt D.C. "Nife" accumulator.

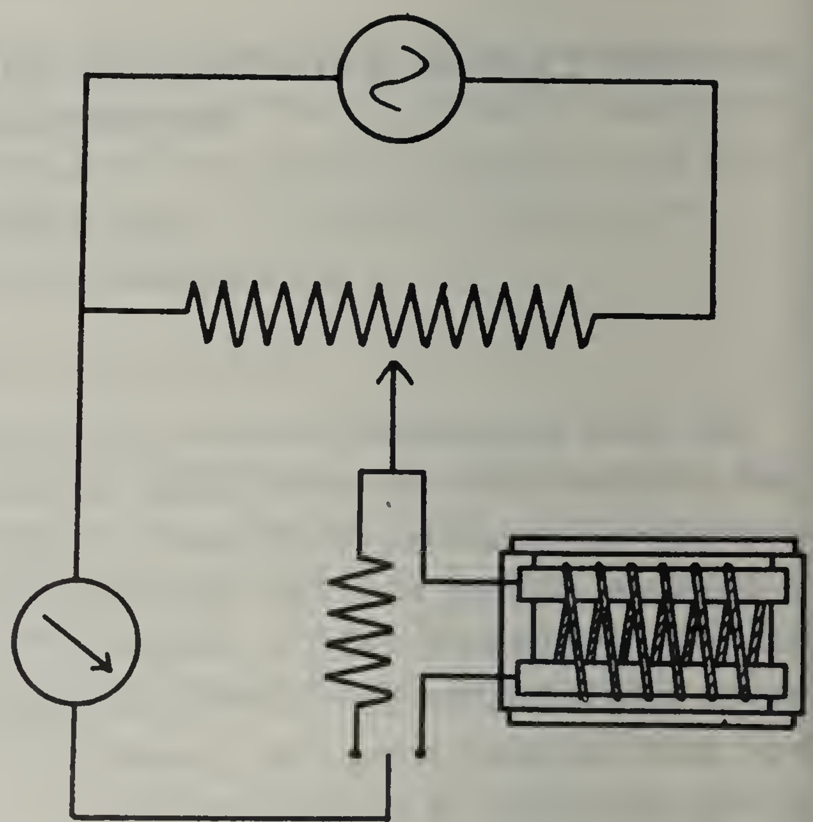

Fig. 1. Wiring diagram of the hygrometer and measuring instrument.

The resistivity of the glass-fibre spiral varies not only with the humidity but also with the amount of calcium chloride present, and the range of the instrument can be modified in this way. Thus an element which is to be used over a range of relative humidities from 50 % to saturation will require less salt than one which is to be used for the drier end of the humidity scale. The precise amount depends, of course, upon the size of the element: for the one described it is of the order of 3 or 4 drops of a 0.5 % solution of calcium chloride. The element is calibrated in closed vessels over standard mixtures of sulphuric acid and water, or saturated salt solutions. It is essential that the temperature be controlled during calibration, and the air in the vessels should be gently stirred. The element adjusts rapidly to humidity changes, but half an hour is necessary for full equilibration, and at humidities above 90%, an hour is preferable. Resistivity of the filament also varies with temperature, so that it is necessary to calibrate in at least three different, constant temperatures. The temperature is measured by a small thermocouple, made of 36 gauge copper and constantan wires, one junction being attached to the hygrometer, the other kept in a vacuum flask of water at a known temperature. The thermocouple is read by means of a portable spot galvanometer.

The hygrometer, in the writer's experience, is subject to a small amount of hysteresis, but this can be minimised by keeping the element when not in use in a constant humidity, in the middle of the range, and always going into an unknown humidity from this known humidity.

With care, and allowing for temperature effects, an accuracy within 2% R.H. can be obtained. One drawback of the instrument is that it cannot be

exposed to saturated air for long without going out of calibration, for there is a danger of water droplets forming and carrying away some of the salt. Replacement of salt lost and recalibration is then necessary. The measurements described below, which were made in the field to test the instrument under such conditions, will serve to show the kind of problem which can be investigated.

The distribution of the terrestrial Isopods, or woodlice, is often said to be determined to a great extent by humidity, yet little is known of the microclimates which they inhabit, and so far as I know, the temperature and humidity conditions have never been precisely measured. General observation suggests that the problem might prove to be interesting and fairly complex: it is not uncommon, for example, to see woodlice moving about in exposed conditions in bright sunlight – behaviour which, at first sight, appears not to fit in with what is known of the ecology, particularly the water economy, of these animals. Such behaviour can be observed, for instance, near the sea shore, where *Ligia* and *Porcellio* are often exposed on insolated rock surfaces for considerable periods of time (up to two minutes has been observed, and without doubt much longer exposures occur). It was therefore decided to investigate, with the instruments now available, the microclimatic conditions which obtain in such situations, and to see whether the measurements would throw any light upon the behaviour mentioned. The observations were made at Dale Fort Field Centre in the summer of 1951.

Now it can be shown in the laboratory (EDNEY, in press) that woodlice, unlike most insects, lose water rapidly through the integument into unsaturated air, and that this has a considerable cooling effect. *Ligia*, for example has a body temperature which is 7.0° C lower than the surrounding dry air at 30° C. Measurements were first made to find whether this cooling effect does in fact occur in the field. Three specimens of *Ligia oceanica* were used; one was alive, another recently killed, and the third dead and thoroughly dry. A small thermocouple was inserted through the rectum of each, and they were placed side by side in the sun on the upper surface of a small quay where *Ligia* were often to be seen. A fourth thermocouple was placed with the hot junction in contact with the surface of the quay – it was constructed of 47-gauge wires which are so thin as to be affected only to a very small extent by direct radiation, and it can be safely assumed that the true temperature of the surface was measured. The experiment was allowed to run for half an hour, and readings were taken of the temperature of each thermocouple from time to time. Briefly the results showed that whereas the temperature of the surfaces of the quay remained within the range 34°- 36° C during the whole period, that of the living and freshly killed *Ligia* varied from 26°- 28° C and that of the dried specimen rose during the first ten minutes to within half a degree of the quay surface temperature. The shade temperature of the air at the time was 19° C and the temperature of the air 2 cm. above the quay was 21° C. The air was moving gently at the time. The relative humidity of the air above the quay was surprisingly low, one

hygrometer read 66% and another 68%. Thus there is no doubt that the evaporation of water from living or recently dead *Ligia* reduces their temperature in these conditions by about 8° C. The living specimen was still alive, though comatose, after the half hour period. It was held in place on the surface by a strand of cotton fixed down with plasticene.

The conditions were next measured in a sheltered and insolated part of a bay, just above high tide mark, where the shingle gave place to nearly vertical Old Red Sandstone rocks. *Ligia* was often seen walking over the rocks, and large colonies of the species were to be found under the stones at the foot of the rocks, where there was a good deal of decaying organic matter. The humidity under the shingle, amongst the colonies of *Ligia*, was very nearly at saturation point, and the temperature was as high as 30° C (due to insolation of the upper surfaces of the stones). The temperature of the surface of the rock varied considerably from place to place; the highest measured was 38° C, but small crevices, changes in angle and colour etc., were sufficient to provide a large range of temperature conditions over the whole area. The relative humidity near the rock surface was again surprisingly low, figures varying between 60 % and 70 % were obtained; but since

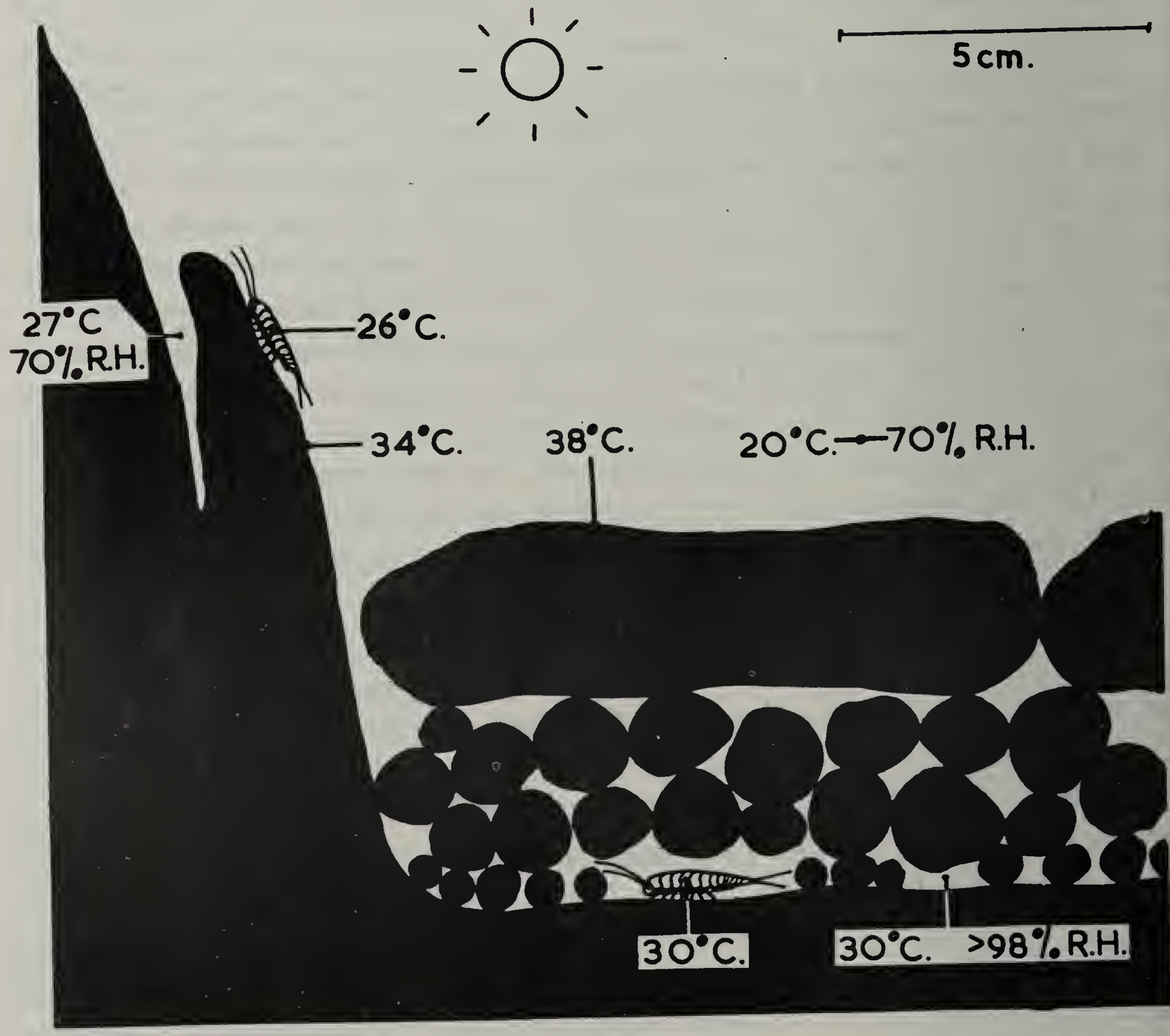

Fig. 2. Diagram to illustrate a typical set of microclimatic conditions, at the foot of a Red Sandstone cliff near the sea shore, which might be responsible for the migration of *Ligia* from below the shingle to the insolated cliff surface.

the air was moving, there was no very great difference between the humidity figures above the surface and in the crevices, unless the latter were very deep, when the humidity rose to 92%.

The conditions of temperature and humidity described above suggest a possible explanation of the behaviour of *Ligia* (see fig. 2). The upper lethal temperature of this animal, for one hour exposure in saturated air, is 32.5°C (EDNEY 1951), and for longer exposures the lethal temperature is rather lower. Now the temperature under the shingle, where the animals normally live, rising as it does at least to 30° C (and probably higher at times) is considerably above the optimum range, and since the air is saturated, the animals' body temperature is at least as high as that of the environment. It seems not unlikely, therefore, that the animals migrate upwards to a region where, even though they are exposed to direct insolation, they can lose water freely and thus reduce their body temperature. A time will come, of course, when a continued loss of water can no more be tolerated (50% by weight can, however, be lost before death is caused), and the animal is forced back into a region of high humidity.

The above explanation of the observed behaviour is put forward only tentatively. Clearly more critical observations are necessary to confirm the theory, in particular it will be necessary to trace the whole course of a migrating animal, to see whether in fact it does come up from the colonies under the stones and eventually go back there, and it would be preferable also to produce similar migrations under laboratory conditions where adequate control or variables is possible. Nevertheless, it is hoped that this account will serve to indicate the kinds of problem which await investigation with small measuring instruments.

The work described above was carried out while in receipt of a grant from the Agricultural Research Council. The author is also indebted to Mr. E. RORKE, of Messrs. NEGRETTI & ZAMBRA, for constructing the original hygrometers.

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DISCUSSION

Mr. **Kuenen**: a. If calibration requires circulating air, how do we know we get the right R.H. in the field in stagnant air? b. What is time of adaptation?

Mr. **Edney**: a. Waiting to constant reading gives sufficient certainty of right R.H. b. Time of exposure ½ hour up to 90% R.H. and 1 hour above.

Mr. **Varley**: a. Does the gauze round the humidity element alter the tem-

perature? b. Is the temperature of *Ligia* near the wet-bulb temperature?

Mr. **Edney**: a. Not much. b. Almost exactly.

Mr. **Weis-Fogh**: The body temperature of *Ligia* was considerably lower than the surface temperature of the substratum, but can this difference in temperature be due solely to evaporation? It was emphasized that neither the surface temperature nor the temperature of the air should be chosen as a basis for estimating the eventual effect of evaporation because *Ligia* was situated in a steep gradient of temperatures.

Mr. **Edney**: It can be shown, both in the laboratory and in the field, that the body temperature of living or recently killed *Ligia* is several degrees lower than that of a dead and dried specimen if the surrounding air is dry. In the field, the amount of this difference in temperature at any time will, of course, depend upon the interaction of a number of factors, of which the speed of movement and the temperature of the air are two.

Mr. **Buxton**: It is remarkable that the Isopod can cool itself so much as 7^{o} C. This argues a very rapid loss of water. For how long can the animal tolerate so rapid loss of water?

Mr. **Edney**: In our experiments for half an hour.

DIE BEDEUTUNG DES EINZELGESCHEHENS IN DER GRADOLOGIE

von

Walter THALENHORST

Sieber/Harz, Deutschland

Untersuchungen über die Populationsdynamik von Insekten sind bisher im wesentlichen dann angestellt worden, wenn das Objekt in relativ hoher Populationsdichte vorkam, also etwa bei Massenvermehrungen von Schädlingen. Grundlagen solcher Untersuchungen sind statistische Erhebungen, die an einem möglichst grossen Zahlenmaterial vorgenommen werden. Erhebungen über die Produktion basieren etwa auf der Aufstellung von Durchschnittswerten für die Zahl der ablagefähigen Eier. Oder es interessiert der Abgang an Individuen innerhalb eines bestimmten Stadiums durch Parasiten, Räuber und Krankheiten: ein Wert, der sich wiederum als Durchschnittswert in Prozent der Ausgangsbevölkerung angeben lässt. Immer wird also nach Durchschnittswerten gesucht. Was mit dem einzelnen Tier geschieht, interessiert nicht; höchstens die Extreme werden noch einer gewissen Beachtung gewürdigt.

Auf diesem Wege haben wir interessante Aufschlüsse über die Populationsdynamik von Insektenarten auf dem Höhepunkt ihrer Massenvermehrung und während des darauf folgenden Zusammenbruchs der Gradation erhalten. Es fehlen aber – mit wenigen Ausnahmen – Bevölkerungsanalysen während des sog. „eisernen Bestandes" oder der „Latenzperiode" der Gradation, also im oft langjährigen Minimum der Populationsdichte. Allein solche Analysen aber liefern uns erst den Schlüssel zum Verständnis der Ursachen der Massenvermehrungen, und es ist von massgebenden Forschern immer wieder auf die Notwendigkeit derartiger Untersuchungen hingewiesen worden.

Dass sie fehlen, hat zunächst rein praktische Gründe. Einmal erscheint die Bearbeitung eines Schädlings, der sich im eisernen Bestand befindet, wenig dringlich; zweitens ist es in dieser Phase schwierig, das notwendige Material für statistische Erhebungen zu sammeln, dann also, wenn nur hier und da einmal ein Ei, eine Raupe, eine Puppe oder ein Vollkerf gefunden wird. Aber gerade damit kommen wir an einen Punkt, an dem meiner Überzeugung nach grundsätzliche Bedenken anzumelden sind. Die hier zur Diskussion gestellte Frage lautet: ist in dieser Phase des eisernen Bestandes die statistische Untersuchungsmethode überhaupt noch anwendbar, oder stehen wir hier etwa vor einer ganz andersartigen Situation, die auch grundsätzlich neue Untersuchungsverfahren erfordert, vielleicht sogar ganz neue Denkwege? Mir scheinen sowohl prinzipielle wie methodische Gründe für diese zweite Alternative zu sprechen.

Ich möchte mich dabei auf gewisse Erkenntnisse der modernen Physik berufen. Physik und Entomologie haben an sich wenig miteinander zu tun, aber es bestehen doch in der Natur grundlegende Gesetzmässigkeiten, die

sich in allen Bereichen auswirken, und es erscheint mindestens einer Überlegung wert, ob nicht auch die Entomologie aus den neuen Erkenntnissen der Physik einige Anregungen erfahren könnte. Ich kann nur beiläufig darauf hinweisen, dass andere Disziplinen der Biologie, z.B. die Genetik, schon seit einiger Zeit solche Parallelen mit Gewinn verfolgen.

Im vorliegenden Zusammenhang interessieren besonders zwei Grundsätze der Mikrophysik, die ihr Gegenstück im Arbeitsbereich der dynamischen Ökologie als eines Teilgebietes der Entomologie finden könnten.

1. Die Gesetze der Makrophysik haben sich als blosse statistische Gesetze herausgestellt, die nur für eine Vielzahl von Einzelfällen gelten. So ist etwa die Temperatur eines Gases bekanntlich nichts anderes als die augenblickliche Geschwindigkeit seiner Moleküle – wohlgemerkt aber deren Durchschnittsgeschwindigkeit. Es ist damit nicht gesagt, dass alle einzelnen Moleküle genau die gleiche Geschwindigkeit besitzen; es gibt solche, die sich langsamer, und solche, die sich schneller bewegen, als es der Durchschnittstemperatur entspricht, und selbst ein und dasselbe Molekül kann seinen komplizierten Weg einmal mit höherer, dann wieder mit niederer Geschwindigkeit zurücklegen. Von einer Temperatur können wir also nur dann reden, wenn wir eine genügend grosse Zahl von Molekülen vor uns haben. Je geringer diese Zahl wird, um so grössere Bedeutung gewinnt der Einzelfall, also die Geschwindigkeit des einzelnen Moleküls, und es wird schliesslich sinnlos, für einen Raum, in dem nur ein paar Moleküle umherfliegen, eine Temperatur anzugeben. In der Mikrophysik gilt, allgemein gesprochen, nicht mehr das statistische Gesetz, sondern bekommt der Einzelfall sein Gewicht.

2. Die makrophysikalischen Vorgänge werden durch Beobachtungsapparate des Menschen, also z.B. Messinstrumente, nicht oder doch nur wenig beeinflusst. Der Planet Jupiter wird in seiner Bahn nicht gestört, wenn der Astronom sein Fernrohr auf ihn richtet. Aber schon die Anbringung eines Thermometers kann die Temperatur eines kleinen Objekts in gewissen Grenzen beeinflussen; immerhin lässt sich der dadurch entstehende Fehler der Messung zumeist technisch oder rechnerisch ausschalten. Bei der Beobachtung eines einzelnen Atoms oder Lichtquants wird diese Störung jedoch so überwältigend gross, dass über den wahren Ablauf eines bestimmten Vorgangs gar nichts mehr ausgesagt werden kann.

Und nun die Anwendung dieser Erkenntnisse auf die dynamische Ökologie:

1. Die Verhältnisse der Makrophysik vergleiche ich mit dem Zustand einer Insektenart auf dem Höhepunkt der Massenvermehrung oder wenigstens kurz vor oder nach ihr. Wir arbeiten mit grossen Populationen, deren (vielfach gesetzmässiges) Verhalten durch statistisch fassbare Durchschnittswerte charakterisiert werden kann, wie ich es eingangs schon näher ausführte. Im eisernen Bestand ist das aber anders. Wir haben keine Populationen mehr vor uns, für die wir statistische Durchschnittswerte aufstellen könnten, wir haben nur hier und da Einzelindividuen. Nicht nur wird dadurch methodisch unsere Arbeit erschwert – wir könnten ja schliesslich unsere Arbeitsfläche

erweitern und damit doch so viele Individuen erfassen, dass sich wieder Durchschnittswerte gewinnen lassen. Auf die Gefährlichkeit dieses Gedankens komme ich noch zurück. Nein: bei einer solchen sporadischen Verteilung der Art im Biotop bekommt, wie in der Mikrophysik, der Einzelfall sein Gewicht, d.h. die einmalige Konstellation von Ursachen, die diesen Einzelfall bestimmt. Das Individuum – als Träger eines solchen Einzelfalles und Knotenpunkt des Kausalitätsgefüges – ist aber potentiell wieder der Ursprung einer Population, also der Ausgangspunkt einer zukünftigen Massenvermehrung!

Ich darf vielleicht einmal ein Beispiel konstruieren. Auf dem Höhepunkte der Massenvermehrung sollen die Weibchen einer beliebigen Insektenart eine durchschnittliche Eizahl von 100 haben mit den Extremen 50 und 150. Die Mortalität unter diesen Weibchen vor der Eiablage (also etwa noch im Puppenstadium durch Parasitierung) soll 50% betragen. Dadurch braucht die durchschnittliche Eizahl nicht weiter beeinflusst zu werden, denn es werden wohl mit gleicher Wahrscheinlichkeit stärkere und schwächere Tiere betroffen. Im eisernen Bestand – als Gegenbeispiel – habe ich in einem bestimmten Biotop nur 2 Weibchen, eines mit 50 und eines mit 150 Eiern. Man könnte auch hier rein rechnerisch einen Durchschnittswert von 100 Eiern setzen, aber offenbar zu Unrecht. Auch jetzt soll die Parasitierung 50% betragen, und das heisst nunmehr: es wird eines der beiden Weibchen vor der Eiablage ausgeschaltet. Da bedeutet es aber einen grossen Unterschied, ob das Weibchen mit 50 oder dasjenige mit 150 Eiern am Leben bleibt: nämlich einen Unterschied von 1:3! Die Entscheidung darüber hängt, wie ich schon andeutete, von einer ganz bestimmten einmaligen Konstellation von Ursachen ab, die den Parasiten gerade an die eine oder an die andere Puppe heranführt. Von einer Gesetzmässigkeit kann hier nicht mehr die Rede sein; wie weit wir von einem Zufall sprechen und dem Geschehen einen Freiheitsgrad zubilligen dürfen, soll dahingestellt bleiben.

Natürlich ist dieses Beispiel, dem man andere zur Seite stellen könnte, roh konstruiert; es zeigt aber die Probleme, mit denen wir uns bei Untersuchungen während der Latenzperiode des Massenwechsels auseinanderzusetzen haben.

2. Wenn ein Insekt bei hoher Populationsdichte auftritt, so ist es belanglos, wenn ich auch wiederholt einige Hundert Exemplare abfange und etwa auf Eizahl oder Parasitierung untersuche, also vorher abtöte. Die Weiterentwicklung des Geschehens wird dadurch so gut wie nicht gestört. Tritt die betreffende Art aber nur in wenigen Exemplaren auf, so übernehme ich selbst die Rolle des oben erwähnten Zufalls: ich lösche unter Umständen sogar durch das Abfangen des vielleicht einzigen Exemplares eine Art im Biotop aus und beeinflusse damit entscheidend die zukünftige Entwicklung. Natürlich kann ich rein statisch eine Bestandsaufnahme machen, also etwa an einem Tage alle im Biotop vorhandenen Insekten abfangen, präparieren und determinieren und danach gleichsam einen zeitlichen Querschnitt durch die Biocönose ziehen. Ihre Dynamik wird aber durch einen solchen Querschnitt

nicht gekennzeichnet; im Gegenteil, ich würde sie mit diesem Verfahren einschneidend stören. Vielfach mag der Verlust an Individuen, der durch das Abfangen entsteht, sehr bald wieder aufgefüllt werden, aber in gewissen Fällen ist dies eben nicht mehr möglich, und damit dränge ich vielleicht das dynamische Geschehen in eine ganz andere Richtung, als es ohne meinen Eingriff eingeschlagen hätte. Dieser Fehler wird um so grösser, je mehr Material ich sammele, um etwa doch noch zu einer statistischen Auswertung zu gelangen; wenn ich also meine Fänge, je seltener die untersuchte Art vorkommt, auf immer grössere Flächen ausdehne. Das bedeutet also, dass wir für solche Arbeiten eine ganz neue Methodik entwickeln müssen. Streng genommen dürften wir kein einziges Exemplar aus dem Biotop entfernen, sondern müssten es lediglich registrieren und dann wieder freilassen. Welche Erschwernisse das etwa bei der Erfassung der Ichneumoniden und anderer unübersichtlicher Gruppen bedeutet, kann man sich vorstellen, und man wird froh sein, wenn man auf irgendeine Weise wenigstens einen Kompromiss zwischen der strengen Forderung und den praktischen Möglichkeiten findet.

Die Neuartigkeit dieser Probleme bringt es mit sich, dass noch von keinen Erfahrungen auf diesem Wege berichtet werden kann. Es lässt sich noch nicht einmal aussagen, wo überhaupt die Grenze zwischen Mikrogradologie (wenn ich es einmal so nennen darf) liegt. In vielen Fällen mögen auch im eisernen Bestande statistisch fassbare Gesetzmässigkeiten walten, aber z.B. die Tatsache, dass am gleichen Ort mal die eine, mal die andere Parasitenart in den Vordergrund rückt, kann vielleicht durch ein solches mikrogradologisches Einzelgeschehen am Anfange der Massenvermehrung bedingt sein. Es sind damit mehr Fragen aufgeworfen, als im Augenblick beantwortet werden können: hier sollte nur einmal kurz die Situation mit ihren Schwierigkeiten gekennzeichnet werden. Wir müssen aber meiner Ansicht nach in der aufgezeigten Richtung vorwärts gehen, wenn wir empfindliche Lücken in unserer Kenntnis von den Ursachen der Massenvermehrungen schliessen wollen.

DISCUSSION

Mr. **Hase**: Vergleiche zwischen Mikrophysik und verringerter Populationsdichte sind meines Erachtens nur theoretisch möglich. Praktisch fällt die Frage dann mit der Frage des Aussterbens einer Art zusammen.

Mr. **Thalenhorst**: Das Problem muss aber auf jeden Fall einmal durchdacht werden: hierzu anzuregen war der Zweck dieses Vortrags.

Mr. **Handschin**: Ich möchte hervorheben, dass es doch einen Unterschied zwischen Population und Individuendichte gibt, die wohl im Referat verwechselt worden sind.

Mr. **Thalenhorst**: „Population" wird in der Gradologie in dem gleichen Sinne gebraucht, in dem wir von „Populationsdichte" (= Individuendichte = Abundanz) sprechen, also als etwas statistisch Fassbares im Gegensatz zu dem sich der Statistik entziehenden Einzeltier.

DIE BEDEUTUNG DER INSEKTEN FÜR DIE BESIEDELUNG KLEINER LEBENSSTÄTTEN

von

H. J. STAMMER

Erlangen, Deutschland

Die ausserordentliche Bedeutung, die die Insekten als Überträger von Krankheitserregern aller Art für Mensch, Tier und Pflanze haben, ist gemeinhin bekannt. Dass weiterhin die Insekten ganz allgemein Bakterien, Pilze und Protozoen verschleppen und verbreiten, ist gleichfalls beinahe jedem geläufig. Dass aber die Insekten darüber hinaus eine wichtige Rolle übernehmen, indem sie vielfach zahlreiche Metazoen verschleppen und diese dort ansiedeln, wo sie neue Lebensstätten finden, ist meiner Meinung nach eine bisher viel zu wenig beachtete Tatsache.

Am Erlanger Zoologischen Institut beschäftigen wir uns mit den Wechselbeziehungen zwischen Insekten und anderen Tiergruppen seit etwa 5 Jahren. Wir untersuchten insbesondere zwei Tiergruppen in ihrem Verhalten gegenüber den Insekten, die Nematoden und Acarinen. Beide Gruppen sind auf dem Lande allgegenwärtig, überall treffen sie mit den Insekten zusammen; so konnten sich zwischen ihnen und den Insekten die mannigfachsten Beziehungen knüpfen.

Beide Tiergruppen sind verhältnismässig wenig ortsbeweglich. Die einfachste Möglichkeit, ihren Aktionsradius zu vergrössern, ist die Ausnützung der hohen Ortsbeweglichkeit der Insekten. In viel weiterem Umfang, als dies bisher bekannt war, wird von dieser Möglichkeit sich verschleppen zu lassen bei den Nematoden und Acarinen Gebrauch gemacht; die folgenden Zeilen werden das belegen.

Im Laufe von 5 Jahren haben meine Schüler und ich in der näheren und weiteren Umgebung von Erlangen insgesamt 332 Arten oder Unterarten von land- oder süsswasserbewohnenden Nematoden festgestellt. Von diesen 332 Formen leben 240 saprob, 33 terrestrisch, ohne ausgesprochen saprob zu sein, 7 amphibisch, 37 aquatisch und 15 pflanzenparasitisch. 140 Arten, d.h. 42% aller Arten, lassen sich von Insekten verschleppen und sind zum Teil an sie gebunden. Dieser Prozentsatz ist verhaltnismässig sicher zu hoch, ebenso der Anteil der Saprobionten, da die Untersuchung nicht saprober Standorte bisher von uns erst begonnen, aber noch nicht zu Ende geführt wurde. Doch glaube ich nicht, dass er nach Erfassung aller Nematodenarten unter 30% sinken wird.

Bei den Milben ist eine Gesamterfassung der Arten infolge der geringen Kenntnis und unvollkommenen systematischen Bearbeitung dieser Tierordnung nicht möglich. Ausserdem haben ganze Gruppen, wie die Oribatei, und

viele Familien der Milben keine Beziehung zu Insekten. Wir haben die Milbenfauna der Erlanger Umgebung durch morphologische Bearbeitung einzelner Familien zu erfassen begonnen, wobei wir zunächst die Familien untersucht haben, die Beziehungen zu Insekten aufweisen. Bei ihnen liegt der Prozentsatz der Tiere, die sich durch Insekten und Myriapoden, die ich hier mit einbeziehe, verschleppen lassen, noch höher als bei den Nematoden.

Von 73 in der Umgebung Erlangens beobachteten Tyroglyphiden-Arten (ohne Anoetinen) lassen sich 49, d.h. zwei Drittel, verschleppen, von 44 Anoetinen-Arten 37, von 42 Scutacariden-Arten 22 und von 38 Arten der Gattung *Digammasellus* 9, insgesamt also von 197 Milbenarten weit mehr als die Hälfte, nämlich 117 Arten. In welchem Umfang die Insekten die Milben verschleppen, sollen zwei Beispiele zeigen. Meine Schülerin E.LIPPERER beschäftigt sich z.Zt. mit den Milben der *Necrophorus*-Arten. Die 628 untersuchten *Necrophorus*individuen trugen insgesamt 13 706 Milben der Gruppe der Mesostigmata, die 11 Arten angehören; jeder Totengräber führt also im Durchschnitt 21 Milben mit sich. Dabei sind aber die Anoetinen und Tyroglyphiden, die oft zu Hunderten auf diesen Käfern sitzen, nicht mitgezählt worden. Ich selbst untersuche z.Zt. die an Carabiden lebenden Milben. Ich fing Mitte Juni 1951 an einem Teichrand 162 Carabiden; sie waren mit 5 466 Milben besetzt, d.h. jeder Carabide trug durchschnittlich 33 mit sich. Natürlich ist die Zahl der Milben von der Grösse des Insekts abhängig. Im angeführten Beispiel besass jedes Exemplar des etwa 12 mm grossen *Anisodactylus binotatus* Fabr. (31 Exempl.) 106 Milben, dagegen jedes des nur 3,5 mm grossen *Acupalpus dorsalis* Fabr. (75 Exempl.) 19.

Selbstverständlich ist die Zahl der von Insekten verschleppten Tiere weitgehend vom Biotop abhängig. Ende Juni 1951 fing ich in zwei Sandgruben 178 Carabiden; auf diesen befanden sich insgesamt 184 Milben. In Anbetracht dessen, dass Sandgruben für Milben eine recht ungünstige Lebensstätte darstellen, ist ihre Anzahl recht beträchtlich und zeigt das Ausmass der Verschleppung; andererseits ist dieser Befall im Vergleich zu dem der Carabiden des Teichrandes natürlich gering.

Die Möglichkeit sich verschleppen zu lassen wird bei vielen Tieren zur Gewohnheit, und diese führt für beide Partner zu oft folgenschweren Entwicklungen. Zahlreiche Insekten haben sich auf ganz bestimmte Lebensstätten spezialisiert. Mit ihnen spezialisieren sich ebenfalls die Tiere, die sich von diesen Insekten verschleppen lassen. So kennen wir eine grosse Zahl von Spezialisten sowohl unter Nematoden als auch unter Milben, die etwa mit den *Necrophorus*arten an Aas oder mit den coprophagen Lamellicorniern an Dung oder mit uferbewohnenden Carabiden, Staphyliniden und Heteroceriden im Schlamm leben. Am weitesten geht diese Spezialisation bei den rinden- und holzbewohnenden Ipiden, Curculioniden und Cerambyciden. Hier hat beinahe jede Käferart ihre artspezifische Milben- und Nematodenbegleitfauna. Von den oben erwähnten 140 Nematodenformen, die durch Insekten übertragen werden, sind nicht weniger als 62 an ganz bestimmte Insekten gebunden. Bei den Milben erfolgt diese Bindung meist nicht so

eng an eine bestimmte Art, sondern nur an Arten des gleichen Biotop, doch kennen wir auch eine ganze Reihe artlicher Bindungen.

Ist nun ein Tier infolge Spezialisierung auf eine Lebensstätte einmal auf die Verschleppung durch das Insekt angewiesen, so muss es mit allen Mitteln auch dieses Insekt erreichen und sich auf ihm solange aufhalten können, bis es in seiner neuen Lebensstätte wieder von ihm abwandern kann. Milben und Nematoden bilden daher Wander- oder Dauerstadien aus; bei den Milben ist es gewöhnlich die sogenannte Deutonymphe, die vielfach mit Klammereinrichtungen und Saugnapfplatten versehen ist. Manche Milbenarten lassen sich allerdings auch im erwachsenen Zustand verschleppen. Bei den Nematoden ist es das zweite Larvenstadium, die sogenannte Dauerlarve, das auf die Insekten aufwandert. Da die Gefahr der Austrocknung trotz der bei diesen Dauerlarven oft verstärkten Cuticula recht gross ist, suchen diese die geschütztesten Stellen am Insekt auf, besonders die Intersegmentalfalten unter den Flügeldecken oder die Genitalsegmente. Sie dringen aber auch weiter bis in den Darm, die malpighischen Gefässe, ja bis in die Leibeshöhle ein. Damit ist gleichzeitig der Weg zum Parasitismus erschlossen. Schon diese in das Innere der Insekten eindringenden Dauerlarven leben meistens eine Zeitlang von den Säften ihrer Trägertiere. Auf ähnlichem Wege dürften sich auch die echten Parasiten entwickelt haben. Meine Schüler W.RÜHM und F.WACHEK haben allein in der Umgebung von Erlangen nicht weniger als 65 Arten solcher leibeshöhlenparasitischen Insektennematoden oder – Unterarten nachweisen können, darunter 41 neue, während die Weltfauna bisher insgesamt nur 85 Arten umfasst.

Diesen Weg zum Parasitismus können wir, wenn auch nicht in so gleitender Reihe, ebenso bei den Milben verfolgen. Mir sind jetzt, was bisher meines Wissens noch nicht beschrieben ist, eine Reihe von Laelaptiden bekannt, die als Larven während der Verschleppung die Rückenhaut der Carabiden durchstechen und sich von Hämolymphe ernähren. Unter den Pyemotiden, die sich oft von Insekten verschleppen lassen, kennen wir eine ganze Anzahl, die zu reinen Ektoparasiten geworden ist, deren gravide Weibchen dann oft eine unglaubliche Physogastrie aufweisen. Die nahe verwandten Podapolipodiden sind sämtlich Ekto- und Endoparasiten von Insekten mit weitgehenden, durch den Parasitismus bedingten Reduktionserscheinungen. Unter den Tarsonemiden ist die Bienenmilbe *Acarapis* auf diesem Weg sicher zum Parasiten geworden. Den oben erwähnten, nicht parasitischen Tyroglyphiden sind die Canestriniiden, die ausschliesslich auf Insekten von Hautsekreten leben, äusserst nahe verwandt. Die Verschleppung der zahlreichen Trombidiiformes und auch der Mehrzahl der Hydracarina erfolgt bei einem gleichzeitigen Parasitismus ihrer Larven.

Wenn ich betonte, dass diese erörterten Wechselbeziehungen bisher wenig bekannt seien, so liegt das auch daran, dass sowohl die Nematoden und Milben als auch die speziellen Lebensstätten bisher wenig untersucht worden sind. Das zeigen klar folgende Zahlen: von den erwähnten 332 freilebenden Nematoden waren bisher 117 unbeschrieben, von den 65 parasitischen,

wie schon angeführt, 41 und von den 197 Acarinen 111, also ein Drittel, zwei Drittel und mehr als die Hälfte aller Arten.

Ich habe bisher nur vom Transport der Nematoden und Acarinen durch Insekten gesprochen. Auch andere Metazoengruppen mögen gelegentlich noch verschleppt werden. Über eine solche „Phoresie" der Pseudoskorpione gab BEIER vor kurzem eine Zusammenstellung. Selbst in diesem Fall können sich auf grösseren Insekten Pseudoskorpione für längere Zeit ansiedeln, um hier von den Milben dieser Insekten zu leben. POSTNER und ich beobachteten in drei Fällen, dass *Bombus*arten den in ihrem Nest lebenden Käfer *Antherophagus nigricornis* Fbr. in ihrem Pelz trugen. Verschiedentlich wurde das Verschleppen von Coccidenlarven durch Insekten beschrieben. Aber gegenüber der Regelmässigkeit des Transportes von Nematoden und Acarinen tritt die Verschleppung anderer Tiere völlig zurück.

Zusammenfassend stellen wir fest: Den Insekten kommt eine sehr grosse Bedeutung bei der Besiedlung neuer, insbesondere eng begrenzter, spezieller Lebensstätten durch andere Tiergruppen zu. Sie verschleppen regelmässig und in viel weiterem Umfange, als bisher bekannt, Nematoden und Acarinen. Sie ermöglichen diesen Tiergruppen dadurch, die Besiedlung von Lebensstätten, die letzteren sonst nicht, oder nur schwer zugänglich wären. Die Verschleppung führt sowohl bei Nematoden als auch bei Milben zur Spezialisierung auf bestimmte Lebensstätten und dadurch auf bestimmte Insekten; die Wirtsspezialisierung führt in vielen Fällen zum Parasitismus.

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DISCUSSION

Mr. **Franz**: Es scheint dass die Phoresie besonders bei der Besiedlung von Habitats, die sich rasch verändern, eine grosse Rolle spielt (z.B. Anhäufungen sich rasch zersetzender Substrate). Hier kommt neben der Verschleppung von Tieren offenbar auch der von Mikroben eine grosse Bedeutung zu und es scheint, dass durch diese Mikrobenübertragung der gesamte Stoffhaushalt der Natur massgeblich beeinflusst wird.

Mr. **Théodoridès**: La contribution du Prof. STAMMER et de ses élèves à l'étude des organismes parasites et commensaux d'insectes est considérable. Je travaille actuellement sur les parasites et commensaux de Coléoptères dans le sud de la France et ai pu mettre aussi en évidence des espèces nouvelles de Protozoaires et d'Acariens. La plupart des Nématodes phorétiques trouvés associés à des Coléoptères étaient nouveaux pour la France.

SUR UNE LARVE D'HYMENOPTERE BRACONIDE PARASITE DE PENTATOMIDES (Hem. Heteroptera)

par

CLAUDE DUPUIS

Paris, France

J'ai décrit en 1947 (Anales Parasitol., 21: 320–327) une larve de Braconide parasite de *Palomena prasina* (L)*) que j'ai rapportée par élimination aux *Euphorinae.***)

Présentement, je connais cette larve de France (région parisienne, Indre et Loire), d'Allemagne (Karlsruhe, G.OUTIN *leg.*) et du Maroc (Mission 1951) chez les hôtes-Pentatomides suivants:

Palomena prasina (L.), stades II–V;
Eurygaster maura s.l., stades III-V;
Eurygaster austriaca (Schr.), stade V;
Dolycoris baccarum (L.), stades III et V, imago;
Eurydema ornata (L.) Stich., imago;
Holcostethus vernalis (Wolff), stade V;
Aelia acuminata (L.) stade V, imago;
Aelia cognata (Fieb.), Stade V.

Sur 115 larves obtenues de 1946 à 1950, trois seulement parasitaient des imagos; ceci ne paraît pas un hasard, car, dans ce temps, j'ai disséqué plusieurs milliers d'imagos des espèces susnommées.

114 des larves observées, du 13 juin au 15 octobre étaient au stade décrit en 1947, lequel est évidemment un stade de longue durée qui ne passe que tardivement au suivant. Celui ci***) ne fut observé qu'une fois chez une *Palomena* , stade V, le 1er août 1950.

N'ayant jamais observé le stade précédant le stade de durée, je pense que l'infestation s'est produite antérieurement à mes récoltes sur des stades en moyenne plus jeunes que ceux disséqués.

La nymphose dépend des faits suivants:

1. Le stade de transition est rare chez les hôtes préimaginaux qui disparaissent pratiquement dès fin septembre.

2. Le stade de transition n'a pas été observé chez les hôtes adultes, seuls résistants aux froids et chez lesquels les stades de durée sont rarissimes.

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*) Simultanément, RUBTZOV (Entomol. Obozrenie, 28:85) et FEDOTOV (Sbornik Vriednaia Tcherepachka, 2:52) signalaient sans description du Tadjikistan et d'Ouzbekistan une larve de Braconide chez *Eurygaster integriceps* Puton.

**) GOIDANICH (Boll. Istit. Entom. Univ. Bologna, 17, 1948: 90) avance le nom d'*Aridelus egregius* Schmiedeknecht.

***) Ce stade diffère du précédent par ses grosses trachées, 10 paires de grands stigmates, des mandibules en sabre. Il a été observé au moment même de sa mue.

Manifestement les larves parasites n'ont que des chances minimes d'achever leur développement dans les régions et dans les hôtes étudiés.

Une certaine fécondité compense peut-être ces circonstances défavorables à la survie de l'espèce.(Cf. les taux de parasitisme cités en Annales Parasitol. 24, 1949: 231–232).

La présente communication atteindra son but si elle incite à préciser la distribution, les hôtes et les circonstances de la nymphose du parasite considéré.

DISCUSSION

Mr. **Johnson:** Is it possible to find the parasites without dissection? Existe-t-il des indices externes de la présence d'une parasite chez l'hôte pentatomide ?)

Mr. **Dupuis:** On ne trouvera que très rarement les larves d'insectes parasites de Pentatomides si l'on n'a pas recours à la dissection. En effet:
1. Les larves de Braconides n'affectent aucunement l'apparence extérieure de leurs hôtes. Elles déterminent un retard de la croissance de ceux-ci, mais la différence de taille qui en résulte n'est appréciable que statistiquement et ne permet donc pas la diagnose des individus parasités.
2. La présence d'une larve parasite de Phasiinae (Diptera) n'est évidente que dans deux cas:
a. Si le Phasiine appartient aux groupes ovipares, pondant sur l'hôte, son oeuf révèlera le parasitisme; le parasitisme d'une larve d'espèce larvipare (*Ocyptera* par exemple) n'est pas décelable sans dissection.
b. Si le Phasiine est parvenu à un stade (en générale le stade III) où la croissance de la larve détermine un gonflement anormal de l'abdomen de l'hôte accompagné de la protrusion vers l'arrière des segments génitaux; cependant la confusion est possible avec les femelles gravides ou les mâles peu après un accouplement.

En conclusion seule la dissection permet de mettre en évidence sans coup férir la présence d'une larve d'insecte parasite chez les Pentatomides, et, par suite, une appréciation exacte du taux de parasitisme à un instant donné.

SECTION VII

ZOOGEOGRAPHY

THE DISTRIBUTION OF THE SUBGENUS STEGOMYIA IN THE WEST AFRICAN SUBREGION

by

P.F.MATTINGLY

London, England

This group of mosquitoes includes all the proved vectors of yellow fever in Africa. Records of its distribution are therefore fairly abundant. It is remarkable that, apart from a bald statement of the distribution of vector species, no attempt has hitherto been made to assemble and correlate these records or to try to understand them in relation to the physical environment or to the physiological and ethological characteristics of the species concerned. The explanation seems to be that to the medical mind the species appears simply as something exhibiting on the one hand more or less specific morphological characters and on the other more or less specific behaviour patterns. The taxonomist, however, tries to see beyond these characters and to visualise the species as an actual population in nature. To him, therefore, distribution is of fundamental importance.

The West African Subregion, as defined by CHAPIN in his classical work on the birds of the Belgian Congo, comprises two heavily forested areas, the Upper and Lower Guinean Forests, and certain peripheral areas of savanna, the Guinean, Ubangi-Uelle and Uganda-Unyoro savannas to the north and the South Congo Savanna to the south. Only one species of *Stegomyia, Aëdes (S.) apicoargenteus* Theobald, has a distribution even approximately coterminous with the subregion and even this species is known to occur outside it in low-lying parts of CHAPIN's East African Highland district around the Gulf of Kavirondo and in the Kitgum area of Uganda. The distribution of *apicoargenteus* when plotted in detail is found to give a very close fit with the 45" isohyet, the principal exception being afforded by the dry area separating the Upper and Lower Guinean Forests where it has been recorded from Accra and Anecho with mean annual rainfalls of about 25" and 30" respectively. This curious dry area seems to owe its existence to a change in direction of the coast so that the rain-bearing winds blow along instead of across it. Despite the small annual total the seasonal distribution of rain is very equable. At Accra there are on an average only four dry months (i.e. months with less than 1" of rain). A distributional boundary based on the empirical limit of 25" with four dry months or less shows little significant difference from the 45" isohyet in West Africa proper but when it is extended into the eastern part of the range a most interesting divergence is observed. In the neighbourhood of Bor and again further south in the neighbourhood of Juba the boundary appears to turn east, leaving the vast humid area of West Africa, *sensu lato*, and turning away towards the isolated area of high rainfall embracing the Abyssinian Highlands (Fig. 1). In view of the

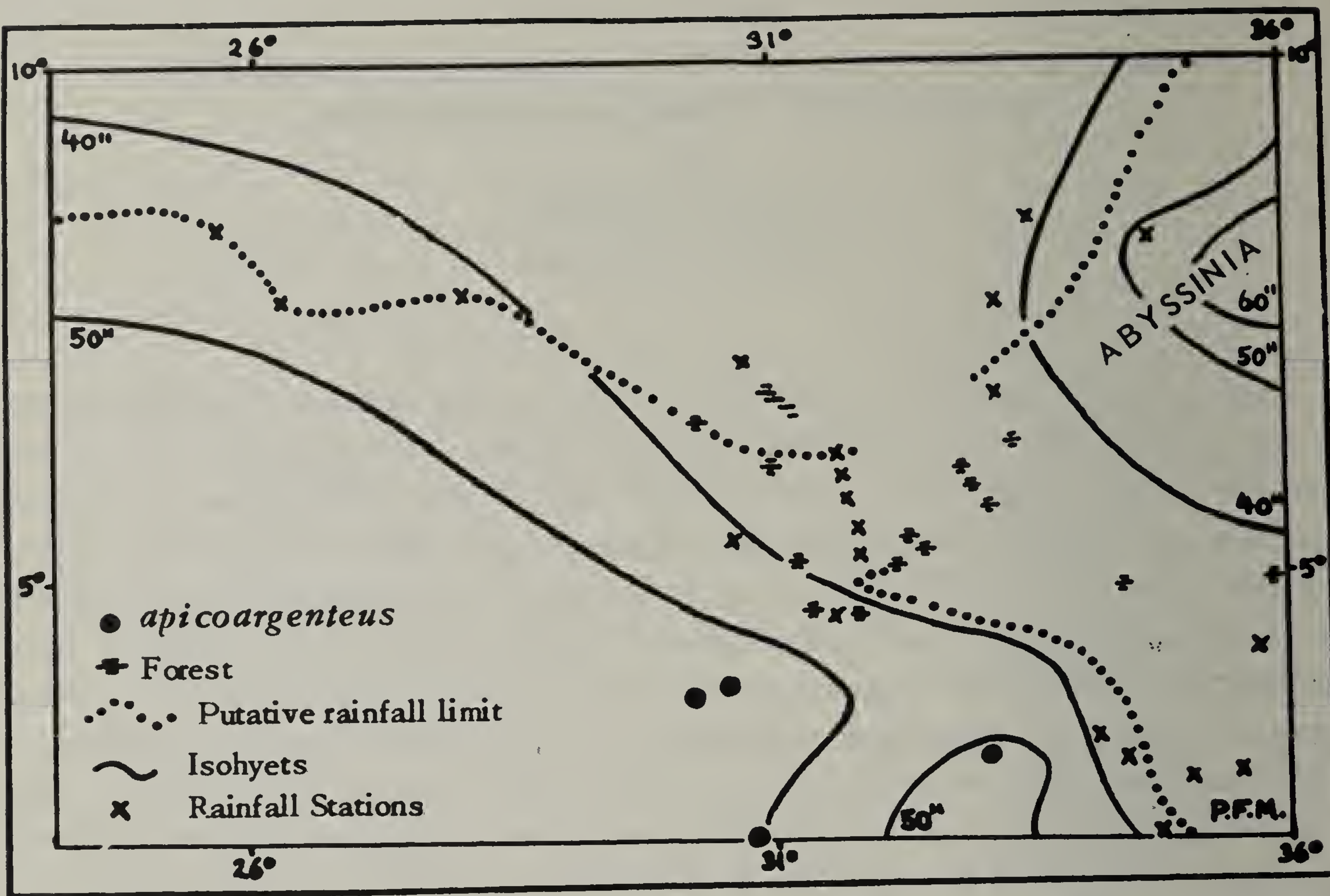

Fig. 1. Distribution of *Aëdes apicoargenteus* in north-eastern Uganda and the Sudan. Only those rainfall stations are shown which are in the critical area.

large number of West African elements which can be recognised in the Abyssinian fauna it is tempting to suppose that we have here the shadow of what was formerly a relatively well watered forest bridge between the two regions. This "bridge" would run across a virtually unexplored part of the Sudan from which no rainfall figures are at present available. It is, however, interesting to note that the large scale map (NB. 36 of the International Series) shows small patches of isolated "forest" having very much the distribution indicated.

The character of the Guinean forests as a barrier to the distribution of the majority of species is well illustrated by the Stegomyias. The only species other than *apicoargenteus* which will normally enter closed canopy forest in this area is *Aëdes (S.) africanus* Theobald. *Aëdes (S.) simpsoni* Theobald is found throughout the region but in the forested area it is almost entirely confined to plantations, shambas and other clearings and it is evident that it has been introduced by man and distributed in the larval stage in the axils of young banana and pineapple plants which are articles of commerce. *Aedes (S.) aegypti* Linnaeus has also almost certainly been introduced by man and *Aëdes (S.) vittatus* Bigot although it has penetrated the north-eastern part of the Lower Guinean Forest has probably done so only along the rivers where it breeds in residual rock pools. *Aëdes africanus* is not known from the dry gap between the Upper and Lower Guinean Forests but otherwise it appears to have similar rainfall limits to those of *apicoargenteus*. With one important

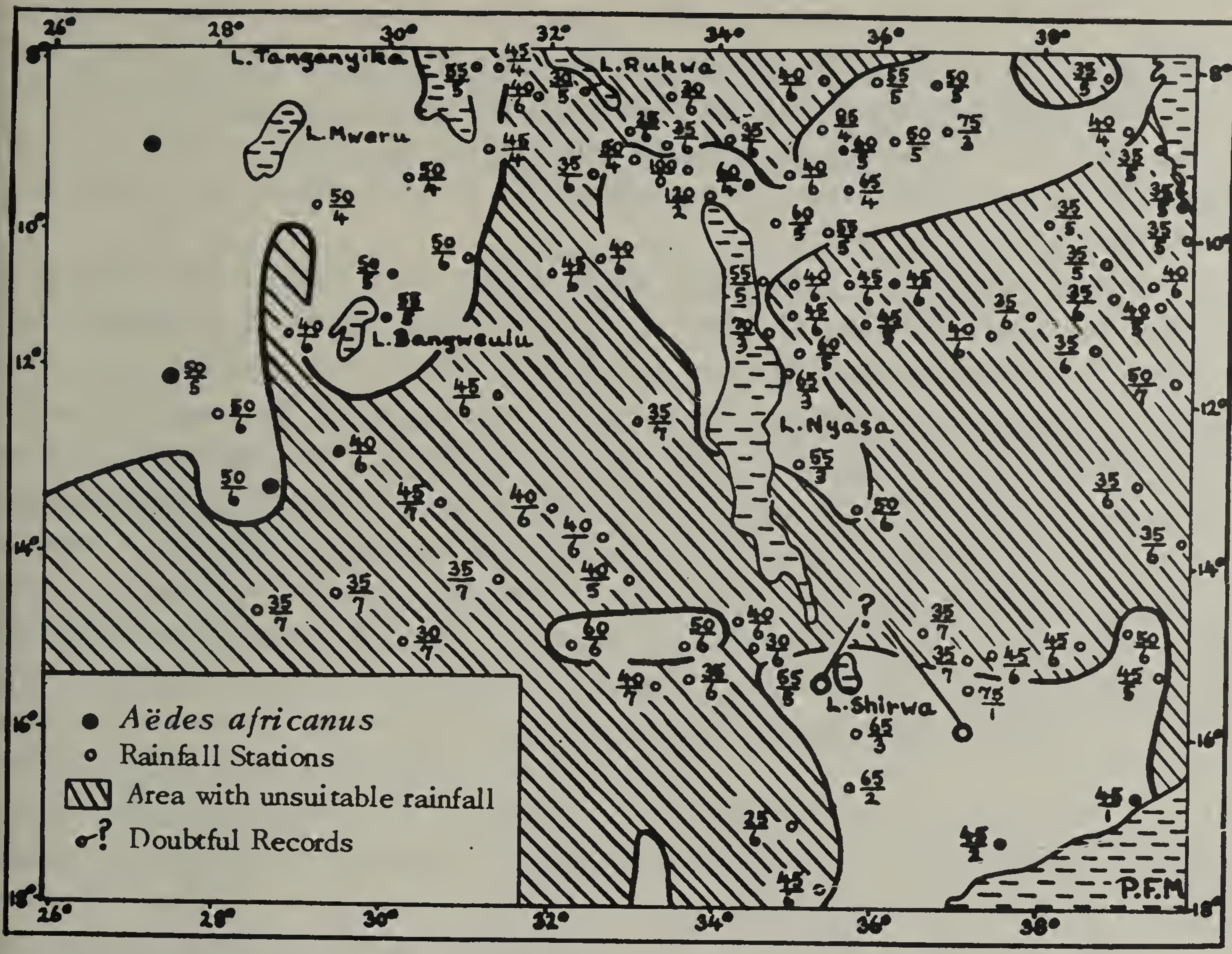

Fig. 2. Distribution of *Aëdes africanus* in the south-eastern part of its range showing rainfall and number of dry months.

exception, discussed below, the empirical limits are 40" with four dry months. 45" with five dry months or 50" with six dry months. It differs from *apicoargenteus*, however, in that it ascends rather higher in the East African Highlands and the same indifference to altitude has permitted it to ascend the northern face of the Rhodesian plateau and to spread well down into Northern Rhodesia. In this region *apicoargenteus* does not appear to ascend above about 3000' or less and its southern boundary is accordingly more or less coterminous with that of the South Congo Savanna. A relict population of *africanus* is known to occur in the Sidamo province of Abyssinia and there are old records, no longer capable of confirmation, indicating the existence of another relict population in an isolated area of high rainfall in Southern Nyasaland and Mozambique (Fig. 2). It is unfortunate that Nyasaland and much of Tanganyika constitute the most serious gap in our present knowledge of *Stegomyia* distribution and the existence of this population still awaits confirmation. A third relict population of *africanus*, recently discovered at Taveta in Kenya, is of special interest both for the light which it throws on the factors governing distribution and as a warning against the danger of assuming distributional limits to be completely definable in terms of a single factor such as rainfall. In the case of *Stegomyia* it would seem that this factor

operates for the most part indirectly through its effect on vegetation. Thus it happens that at Taveta there are very numerous ground springs which support a dense, humid forest of equatorial type and this in its turn gives shelter to an isolated population of *africanus* although the local rainfall is only about 25" a year, far below the empirical limits calculable from its distribution anywhere else in Africa.

It is not possible to refer more than briefly to a few of the remaining species but certain points of interest may be noted. *Aëdes (S.) dendrophilus* Edwards was until recently known only from a narrow belt running along the northern border of the Guinean forests and expanding at its eastern end to embrace the Uganda-Unyoro savanna and certain parts of the Kavirondo region. It has now been shown to occur also in the palm forest region of Zululand, Natal and Pondoland. CHAPIN describes comparable distributions among the birds and these appear to reflect a former much greater extension of the african forests. In the light of this discovery it seemed reasonable to predict that *dendrophilus* would also be found in the South Congo Savanna. Very recently a single specimen was collected near Elisabethville in the Katanga and two more specimens from the same area have now been found in the Congo Museum. The mean annual rainfall at Elisabethville is comparable with that found in other parts of the distribution of *dendrophilus* but its seasonal distribution (six dry months in the year) would seem to be well outside any limit deducible from elsewhere. The explanation again seems to reside in the high subsoil water content along the rivers, associated this time with gallery forest.

Aëdes (S.) unilineatus Theobald is of interest since it occurs in India as well as in the Ethiopian region and belongs to an oriental group of *Stegomyia*. Two populations are known to occur in Africa, one occupying the northern savannas as far north as Erkowit in the Sudan, the other occurring in the Zambesi and Limpopo valleys and adjacent areas. It is probable, though not certain, that all three populations are now completely isolated. Close relatives of *unilineatus* are known from Sokotra *(Aë. (S.) granti* Theobald) and from Crete, Macedonia and a small area of Transcaucasia at the eastern end of the Black Sea (*Aë. (S.) cretinus* Edwards). At first sight this distribution might suggest an oriental invasion of the type envisaged by Dr. UVAROV in a previous paper read to this section, but the occurrence of a very curious anectant species (*Aë. (S.) amaltheus* De Meillon & Lavoipierre) in the Rhodesian Highlands may perhaps imply a common origin for both groups in this area followed by a northward and eastward expansion and, in the case of *unilineatus*, a westward movement along the northern edge of the central forests. The most primitive of the Ethiopian Stegomyias (*Ae. (S.) vittatus* Bigot), which is anectant to the subgenus *Aëdimorphus*, is extremely drought resistant and spreads eastwards across Arabia and India as far as Annam. An isolated population occurs in Spain where its rock-pool breeding habits adapt it to a short breeding season in the autumn in the exposed beds of mountain streams.

DIE BEDEUTUNG VERGLEICHENDER UNTERSUCHUNGEN AN BIOCOENOSEN FÜR DIE LÖSUNG HISTORISCH-TIERGEOGRAPHISCHER PROBLEME

von

H. FRANZ

Admont, Austria

Im Gegensatz zu ihrer botanischen Schwesterwissenschaft beschränkt sich die Tiergeographie bis heute weitgehend auf das Studium einzelner aus dem biocoenotischen Verbande herausgelöster Spezies; die vergleichend-area' kundliche Untersuchung der innerhalb derselben Organismengemeinschaft in gesetzmässigem Verbande lebenden Arten ist ebenso wie die Erforschung der Verbreitung der Zoocoenosen selbst noch kaum in Angriff genommen worden. Es ist das ein bedauerliches Versäumnis, denn es gibt tiergeographische Probleme, die nur durch Berücksichtigung der natürlichen Lebensgemeinschaften gelöst werden können.

Die Fruchtbarkeit des biogeographischen Studiums ganzer Organismengemeinschaften beruht auf zwei Gründen. Einerseits wird durch ihre Heranziehung an Stelle einzelner Arten das den jeweiligen Untersuchungen zu Grunde gelegte statistische Primärmaterial wesentlich erweitert, so dass daraus mit erhöhter Wahrscheinlichkeit Schlussfolgerungen gezogen werden können, und anderseits lassen sich aus der Artenzusammensetzung der Biocoenosen als solcher historisch-biogeographische Erkenntnisse gewinnen, die auf andere Weise überhaupt nicht zu erlangen sind. Solche Schlussfolgerungen ergeben sich sowohl aus dem unterschiedlichen Artenreichtum ökologisch vergleichbarer Tierbestände als auch aus der Häufung von Tierformen mit weitgehend gleicher Verbreitung innerhalb derselben Biocoenose. Wir können im folgenden mit Rücksicht auf den knappen Rahmen dieser Darstellung nur die Bedeutung des verschiedenen Artenreichtums der Tiergemeinschaften für die Lösung historisch-biogeographischer Probleme an Beispielen erörtern, die der arealkundlichen Gesetzmässigkeiten dagegen bloss andeuten. Zum tieferen Verständnis der Zusammenhänge sei in Erinnerung gebracht, dass es zwei grosse Gruppen von Ursachen gibt, die Verschiedenheiten im Formenreichtum von Organismenbeständen bewirken können.

Eine erste Gruppe umfasst die ökologischen Wirkungen, die von der Verschiedenheit der rezenten Standortsbedingungen auf die Artenverteilung ausgehen und die allenthalben eine „Auswahl der Arten" nach den beiden von THIENEMANN (1939) formulierten biocoenotischen Grundprinzipien bedingen. Das erste dieser Grundprinzipien lautet: „Je variabler die Lebensbedingungen einer Lebensstätte, um so grösser die Artenzahl der zugehörigen Lebensgemeinschaft". Das zweite wurde von THIENEMANN wie folgt formuliert: „Je mehr sich die Lebensbedingungen eines Biotops vom Normalen und für die meisten Organismen Optimalen entfernen, um so artenärmer wird die Bio-

coenose, um so charakteristischer wird sie, in um so grösserem Individuenreichtum treten die einzelnen Arten auf". Zwischen dem Biotop und der ihn bevölkernden Biocoenose bestehen demnach ökologisch bedingte Beziehungen, die im Artenreichtum der Organismengemeinschaft deutlich zum Ausdruck kommen.

Neben dieser ersten ökologischen Gruppe ist noch eine zweite historische wirksam, die auch bereits von THIENEMANN (l.c.) angedeutet wurde. Sie umfasst die Wirkungen, die vom Wandel der Lebensbedingungen im Laufe der erdgeschichtlichen Entwicklung einschliesslich aller kurzfristigen Veränderungen selbst engbegrenzter Lebensräume ausgehen und die auch ihrerseits eine „Auswahl der Arten" bewirken. Diese Auswahl, der man bisher viel zu wenig Beachtung geschenkt hat, besteht darin, dass jede Veränderung der Umweltbedingungen dazu führt, dass einzelne Arten in für sie ungünstigere Lebensverhältnisse geraten und daher früher oder später im Kampf ums Dasein unterliegen. Es wird zwar durch die Milieuveränderungen dafür zumeist anderen Arten die Eroberung des betroffenen Standortes ermöglicht, die Neueinwanderung vollzieht sich aber um so langsamer, je geringer die Beweglichkeit der betreffenden Tiere ist und wird völlig unmöglich, wenn Veränderungen einander in rascher Folge ablösen. *Es gilt daher gewissermassen als drittes biozönotisches Grundprinzip der Satz, dass Biocoenosen um so ärmer an Arten sind, je öfter und je tiefgreifender sich die Milieuverhältnisse an den von ihnen bewohnten Standorten verändert haben.* Diese Gesetzmässigkeit hat nun nicht bloss eine erhebliche ökologische Bedeutung, sondern lässt auch eine recht weite biogeographische Auswertung zu, was im folgenden näher beleuchtet werden soll.

Der denkbar grösste Gegensatz hinsichtlich der Standortsbedingungen besteht innerhalb der Landbiotope zwischen dem Binnenraum geschlossener Wälder und offenem waldlosen Gelände. Demgemäss sind auch ursprüngliche Wald- und Steppenbiocoenosen in ihrem Artenbestande ausserordentlich verschieden. Beide sind um so artenreicher, je länger den Standorten, die sie besiedeln, ein annähernd gleicher ursprünglicher Charakter gewahrt geblieben ist.

In Mitteleuropa haben bekanntlich im Zusammenhang mit säkularen Klimaschwankungen die Verbreitungsareale bewaldeten und waldfreien Geländes im Quartär wiederholt ausserordentlich starke Grenzverschiebungen erfahren. Nur kleine Areale des eiszeitlich dauernd unvergletscherten Geländes sind dauernd Waldland oder dauernd Steppe geblieben. Diese kleinen Areale bildeten Refugien einer altendemischen Fauna und erweisen sich bis heute als besonders artenreich. Ihnen folgen jene Gebiete, die nach der postglazialen Wiederbesiedlung einerseits dauernd bewaldet, anderseits dauernd Steppe gewesen sind. Auch sie beherbergen relativ alte, schon weitgehend ausgeglichene Lebensgemeinschaften, denen aber jene Tierarten fehlen, die in postglazialer Zeit keine neuen Wohnareale mehr zu erobern vermochten. In weitem Abstand von diesen Urwäldern bzw. Ursteppen folgen alle kulturbeeinflussten Standorte. In ihnen ist, wie meine Untersuchungen mitteleuro-

päischer Bodentiersynusien gezeigt haben (vgl. FRANZ 1950), die Artenmännigfaltigkeit um so geringer, je öfter und tiefgreifender kulturbedingte Standortsveränderungen stattgefunden haben. Brände, Kahlschläge und Aufforstungen von Monokulturen sind im Walde die einschneidendsten Veränderungen, in waldfreiem oder künstlich entwaldetem Gelände sind es Umbruch mit Pflug oder Fräse und intensive langjährige Ackernutzung. Die anthropogene Veränderung der Landschaft hat den Artenbestand der heimischen Organismengemeinschaften ausserordentlich reduziert, das Ausmass dieser Verarmung aber vermögen wir nur durch vergleichendes Studium der Biocoenosen zu erfassen. Dieses vergleichende Studium vermittelt uns nicht bloss eine Vorstellung von dem enormen Ausmasse der anthropogenen Verarmung und Veränderung der Artenbestände, sondern lässt uns auch unschwer die noch in ursprünglichster Form erhaltenen Biocoenosen und Standorte erkennen. Es gibt uns damit zugleich die Möglichkeit, jene ursprünglichsten Objekte in der Natur auszuwahlen, von denen das Studium historisch-biogeographischer Fragen seinen Ausgang nehmen muss.

Der Unterschied im Artenbesatz zwischen ursprünglichen und mehr oder weniger veränderten Biocoenosen ist allerdings nicht in allen Fällen gleich gross. An Standorten, die durch schwankenden Grundwasserstand oder periodische Überschwemmungen regelmässig grösseren Milieuschwankungen ausgesetzt sind, ist er bedeutend geringer als in dauernd dem Grundwassereinfluss entzogenem Gelände. Im letzteren ist die Verarmung an Arten durch Veränderung des Terrains überall äusserst stark ausgeprägt.

In Steppenlandschaften bevölkern zahlreiche xerotherme Arten ausschliesslich solche Flächen, die niemals einer Ackernutzung unterworfen waren. Ich habe dies sowohl in Südostmitteleuropa als auch in Spanien allenthalben an xerothermen Standorten beobachten können. Zu irgend einem Zeitpunkte der Ackernutzung unterworfenes Gelände wird dort ebenso wenig von den „Kulturflüchtern" (vgl. FRANZ 1936, 1938) unter den Steppenbewohnern besiedelt wie ehemals bewaldetes Land. Solchem Gelände fehlen die Arten auch dann wenn dasselbe weitgehend das Aussehen ursprünglicher Steppen wiedererlangt hat. Die Zahl der Kulturflüchter scheint unter den Bewohnern der primären Steppe recht gross zu sein. Es gehören ihr offenbar nicht bloss viele terricole Arthropoden, z.B. Vertreter der Apterygotengattung *Japyx* und der Käfergattungen *Harpalus, Cymindis, Lithophilus* und *Otiorrhynchus* an, sondern sogar auch geflügelte Bewohner der Vegetationsschicht wie die Heuschrecke *Celes variabilis*, der Käfer *Cryptocephalus apicalis* und der Schmetterling *Chondrosoma fiduciaria*. Die Gesamtheit aller ausschliesslich auf primäres xerothermes Steppengelände beschränkten Arten ist selbst in den gut erforschten Gebieten Südostmitteleuropas noch lange nicht erfasst und kann nur durch eingehendes vergleichendes Studium der Steppenbiocoenosen ermittelt werden.

Ähnliche Beobachtungen wie in den xerothermen Steppen kann man im Hochgebirge oberhalb der natürlichen Waldgrenze machen. Auch dort wird ehedem bewaldetes Gelände, gleichgültig ob die Entwaldung auf Grund einer

regionalen Klimaverschlechterung oder durch Rodung erfolgte, von den meisten typisch hochalpinen Tierarten nicht besiedelt. Dies ist die Ursache der grossen Artenarmut der Intercallarzone (vgl. HOLDHAUS 1929), die sich in den Alpen zwischen die subalpine Waldstufe und die hochalpinen Ursteppen einschiebt und in der postglazialen Zeit bewaldet war.

Nur ganz beschränkte Flächen, an denen das Grundgestein zutage tritt, sind auch hier und selbst noch weit unterhalb der rezenten Waldgrenze von „hochalpinen" Arten besiedelt. Diese treten niemals einzeln, sondern stets gehäuft in ganz bestimmten Lebensgemeinschaften auf und bezeugen so die dauernde Waldlosigkeit ihrer meist sehr eng umgrenzten Felsenstandorte (vgl. FRANZ 1951). In den Felsensteppen der nördlichen Kalkalpen begegnen einander heute an zahlreichen Stellen Bewohner der hochalpinen Steppen und solche der kontinentalen Steppen des südöstlichen Alpenvorlandes. Zur ersten Gruppe gehören z.B. die Rüsselkäfer *Otiorrhynchus nocturnus, picitarsis* und *auricapillus,* von denen die beiden letztgenannten in der Weizklamm östlich von Graz noch in bloss 450 m Seehöhe vorkommen. Vertreter der zweiten Gruppe sind u.a. der Diplopode *Dignathodon microcephalus* sowie die Käfer *Platyscelis gages* und *Timarcha goettingensis* (= *coriaria*). Die Biocoenosen der Felsensteppen beweisen damit, dass im heutigen Waldgürtel der Alpen vor der postglazialen Wiederbewaldung die Bewohner der kontinentalen Steppen Südosteuropas und diejenigen der Hochsteppen einander auf breiter Front begegneten und miteinander vermischten.

Dass in ähnlicher Weise wie die Bodenbiocoenosen des waldfreien Geländes auch diejenigen des Waldlandes durch ihre Artenzusammensetzung ihre Geschichte dokumentieren, wurde bereits angedeutet und kann im Rahmen dieses Kurzvortrages nicht näher ausgeführt werden. Es sei nur hervorgehoben, dass selbst das durch Rodung gewonnene Acker- und Grünland durch die Artenzusammensetzung seiner Bodenfauna dort, wo der Boden dem Einfluss des Grundwassers nicht unterliegt, den ursprünglichen Biotopcharakter in vielen Fällen noch erkennen lässt.

Ganz anders ist dies in Inundationsgebieten. In diesen vermögen sich nur solche Arten dauernd zu behaupten, die im Stande sind, das durch Überschwemmung verlorene Gelände in relativ kurzer Zeit zurückzuerobern. Die hierzu befähigten Arten sind aber fast ausnahmslos im Stande, auch die durch Kulturmassnahmen verlorenen Lebensräume wieder zu besiedeln. Das ist offenbar der Grund, weshalb man in Inundationsgebieten und auch im Bereiche der Salzböden vergeblich nach Kulturflüchtern sucht. Eine wesentliche Umstellung des Artenbestandes erfolgt hier nur, wenn die hygrischen Standortsverhältnisse durch dauernde Trockenlegung des Geländes von Grund auf verändert werden. In diesem Falle treten die hygrophilen Arten der ursprünglichen Biocoenosen zu Gunsten mesophiler und nach radikaler Entwässerung selbst xerophiler zurück. Eine gewisse Umstellung des Artenbestandes erfolgt auch bei der Rodung von Augelände; der Unterschied im Artenbestand der Bodensynusien bewaldeter und unbewaldeter Standorte kommt auch innerhalb der Inundationsgebiete zur Geltung. Er ist dort aber

weniger gross und die landwirtschaftlich genutzte Auböden besiedelnden Synusien lassen sich fast stets unschwer von den Bodensynusien bestimmter Auwaldbestände ableiten.

Da die Artenzusammensetzung einer Biocoenose nicht bloss historisch bedingt, sondern ständig von der Konkurrenz der Arten im Kampf ums Dasein beeinflusst ist, unterliegt das Schicksal der einzelnen Arten mannigfachen Zufällen. Es kann deshalb vorkommen, dass eine Art trotz weitgehend gleicher Voraussetzungen an einem Standort vorkommt, an einem anderen aber fehlt. Der Feststellung des Vorhandenseins oder Fehlens einer einzelnen Art innerhalb eines bestimmten Habitats kommt deshalb erst dann eine ausreichende historisch-biogeographische Beweiskraft zu, wenn sie durch gleichartige Beobachtungen an anderen Arten ergänzt wird. Beruht das Fehlen einer Art an einem bestimmten Standorte auf Veränderungen des Milieus in vergangener Zeit, so wurden von diesen stets auch andere Arten in gleicher Weise betroffen. Hierin wird besonders deutlich, dass vor allem bei biogeographischen Studien auf kleinem Raum erst die Untersuchung ganzer Synusien oder doch wesentlicher Teile derselben ein für sichere historisch-biogeographische Schlussfolgerungen genügend umfangreiches Primärmaterial herbeizuschaffen vermag.

Der Beweiswert dieses Materiales steigt noch weiter, wenn es sich zeigt, dass Arten mit gleichen ökologischen Ansprüchen nicht bloss gehäuft in bestimmten Lebensgemeinschaften auftreten, sondern sich auch hinsichtlich ihrer Gesamtverbreitung ähnlich verhalten. Je weiter die Entwicklungsgeschichte einer Lebensgemeinschaft zurückreicht, desto grösser ist im allgemeinen der Prozentsatz der Arten, die infolge eines langen gemeinsamen Schicksals auch eine ähnliche Gesamtverbreitung aufweisen. Dies ist die Erklärung dafür, dass wir bei der Untersuchung der Biocoenosen an Reliktstandorten fast stets auf ganze Gruppen von Arten stossen, die demselben Verbreitungstypus angehören. Das geht so weit, dass die Überprüfung des Artenbestandes solcher Biocoenosen jeweils sehr wertvolle Dienste bei der Ermittlung der demselben Verbreitungstypus angehörenden Arten zu leisten vermag.

Ich hoffe, dass das Gesagte deutlich werden liess, wie sehr die Untersuchung ganzer Biocoenosen an Stelle einzelner, aus dem natürlichen Artenverbande herausgelöster Spezies, tiergeographische Forschungen zu vertiefen und zu erleichtern vermag. Die Beweiskraft meiner Darlegungen hätte durch weitere Beispiele leicht gesteigert werden können, die knapp verfügbare Zeit verbietet es jedoch, auf weitere Einzelheiten einzugehen.

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DISCUSSION

Mr. **Zeuner**: In Britain, secundary forests which have grown up in agricultural land of the Middle Ages are readily distinguishable from primary forest by the poverty of their insect faunas. Two to three hunderd years have not sufficed for the reconstitution of the original forest fauna.

Mr. **Mörzer Bruijns**: Man findet in Holland (wo nur noch ganz wenige Resten der ursprünglichen natürlichen Wäldern da sind) in den ungefähr 40-50 jährigen Kulturwäldern von natürlicher Zusammensetzung noch nicht die ganze Biozönose, die bekannt ist von dem ursprünglichen Wald desselben Typus. Die Biozönose ist aber „normal" in den Wäldern, wenn sie 100-120 Jahre alt sind. Diese Tatsache scheint im Widerspruch mit den Verhältnissen in den oberen Gebirgslagen von denen Dr FRANZ in seinem Vortrag mitgeteilt hat. Sind beide Beobachtungen in einem Gesichtspunkt zu vereinigen?

Mr. **Franz**: Ursprünglich hatten wir in Mitteleuropa und auch in Holland in postglazialer Zeit mit ganz geringer Ausnahme Waldland. Nach der Entwaldung durch den Menschen blieb eine kleine Auswahl der ursprünglich waldbewohnender Arten zurück, wozu gewisse Neueinwanderer kamen. Ein grösserer Prozentsatz von Waldarten hat sich in Hecken und Buschen erhalten und konnte von dort zurückwandern. Trotzdem ist der Gesammtartenbestand sekundärer Waldbestände in Holland zweifelsohne artenärmer als die ursprüngliche Waldbestände. Dies könnte allerdings erst nach umfassendem Studium der Biozönosen Hollands eindeutig nachgewiesen werden.

INFLUENCE DU FACTEUR HUMIDITE SUR LA DISTRIBUTION DES ELATERIDES EN BELGIQUE (Coléoptères)

par
Charles JEUNIAUX,
Liège, Belgique

Différents travaux expérimentaux ont mis en évidence l'existence, chez les larves et les adultes de plusieurs Elatérides, d'une réaction nettement hygropositive. LANGENBUCH (1932), SUBKLEW (1934) et LEES (1943) ont montré que les larves d'*Agriotes obscurus* et *lineatus* ainsi que de *Ctenicera* (*Prosternon*) *tessellatus* sont sensibles au degré d'hydratation du sol, et choisissent les sols les plus humides. LECLERCQ (1947) constata que les adultes de *Lacon murinus* et de *Limonius pilosus*, placés dans les „alternative chambers" de GUNN et KENNEDY, choisissent les taux les plus humides et ne séjournent que dans les compartiments dont l'atmosphère est à peu près saturée en humidité. Devant ces résultats, il est permi de suggérer que la réaction hygropositive est un caractère physiologique et écologique de la famille des Elatérides (LECLERCQ, l.c.).

Nous nous sommes proposé de rechercher dans quelle mesure la répartition des Elatérides de Belgique sur le territoire belge est liée à l'existence de conditions climatiques caractérisées par une humidité élevée.

MATÉRIEL

Nous avons étudié un abondant matériel contenant plus de 10.000 exemplaires d'Elatérides, capturés depuis 1850 sur tout le territoire belge par de nombreux entomologistes de toutes les régions du pays, et répartis dans une douzaine de collections différentes (voir JEUNIAUX, 1951). Nous avons tenu compte également des captures signalées dans les publications belges. (JEUNIAUX, l.c.). Nous avons pu de la sorte dresser des cartes de répartition pour chaque espèce et comparer leur distribution sur le territoire belge avec leur répartition en Europe, telle qu'elle nous est connus jusqu'à présent.

RÉSULTATS

Nous comparons cinq régions du territoire belge de superficie à peu près identique, que nous savons être aussi bien connues et aussi bien prospectées les unes que les autres par les entomologistes et les collectionneurs. Ces régions diffèrent entre-elles par leur situation géographique, la nature du sol, la couverture végétale, etc. Les conditions de température et d'humidité qu'elles présentent sont également différentes et peuvent être illustrées par quelques caractéristiques climatologiques résumées dans le tableau 1 (d'après PONCELET et MARTIN, 1947).

Tableau 1. Comparaison entre les populations d'Elatérides de cinq régions de Belgique

RÉGIONS	Caractérist. climatiques			Espèces d'Elatérides	
	T.	Q.	P.	nombre	en % du n. total
Forêt de Soignes	15°	200 à 210	170	48	57%
Campine Anversoise	15°	200 à 220	160-170	43	51%
Sud de la Meuse (Namur-Dinant)	15°	210	180	36	42%
Lorraine belge	15°	220 à 230	150-170	29	34%
Hautes-Fagnes	12,5° à 13°	320 à 360	200	55	65%

Légende: T.: Températures moyenne pendant la période de végétation (mai - juin - juillet) en °C. Q.: Quantité d'eau recueillie pendant la période de végétation, en millimètres. P.: Nombre moyen de jours à précipitations d'au moins 0,1 mm. (D'après PONCELET et MARTIN, 1947).

Dans ce même tableau, nous comparons la faune en Elatérides de ces régions, en exprimant le nombre d'espèces différentes trouvées en chaque région en % du nombre total d'espèces dont la présence en Belgique est certaine (soit 84 Elatérides différents).

On constate que c'est la région la plus humide de Belgique (les Hautes-Fagnes) qui héberge le plus d'Elatérides, tandis qu'une autre région, élevée en altitude également, mais plus méridionale et plus abritée des pluies (la Lorraine belge) en contient presque la moitié moins. La Forêt de Soignes et le Nord de la Campine, où les précipitations sont moins abondantes et moins nombreuses que dans les Hautes-Fagnes, mais qui sont plus proches de la mer et plus sujettes à l'influence du climat atlantique humide, ont des populations en Elatérides plus riches que la Lorraine belge et moins riches que les Hautes-Fagnes.

DISCUSSION

Afin de discuter le role joué par le facteur humidité dans la localisation des Elatérides telle qu'elle apparaît dans le tableau 1, nous présenterons d'abord les espèces habitant les Hautes-Fagnes, dont la liste détaillée a fait l'objet d'un précédent travail (JEUNIAUX, 1951). Nous grouperons ces espèces en catégories biogéographiques et écologiques et chercherons les raisons de leur présence sur le plateau des Hautes Fagnes. Nous citerons ensuite les espèces qui n'appartiennent pas à cette faune et chercherons les raisons de leur absence.

1. *Espèces propres au plateau des Hautes Fagnes*

A. Onze espèces sont ubiquistes, expansives, la plupart nuisibles aux cultures, abondantes partout en Europe et communes aux cinq régions belges étudiées. Parmi celles ci, *Lacon murinus* L., *Limonius pilosus* Leske, et les *Agriotes lineatus* L., *sputator* L. et *obscurus* L. se sont révélées nettement hygrophiles au cours des expériences citées ci-dessus.

B. Huit espèces sont montagnardes, propres à la Haute-Belgique. Ces Elatérides „montagnards" sont toutefois nettement hygrophiles: ils fréquentent toujours le bord des ruisseaux, les vallées encaissées, etc. On les trouve en effet sur la plupart des affluents de la Meuse, mais pas sur les plateaux exposés. Ces espèces sont d'ailleurs plus fréquentes sur le plateau des Hautes-Fagnes que dans les autres régions de Belgique, moins uniformément humides.

Tableau 2. Abondance relative des espèces montagnardes en Haute-Belgique

Espèces	nombre d'exemplaires capturés depuis 1850 dans		pourcentage d'exempl. des Hautes-Fagnes
	Hautes-Fagnes	Haute-Belgique*)	
Ampedus elongatulus F.	2	13	15%
Quasimus minutissimus Germ.	2	25	8%
Hypnoïdus riparius F.	18	29	62%
Hypnoïdus dermestoides Hbst.	7	24	29%
Limonius parvulus Tanz.	5	40	12,5%
Idolus picipennis Back.	6	26	23%
Pheletes aeneo niger De Gr.	39	87	45%
	79	244	32,3%

*) Soit toute la zône située au Sud du Sillon Sambre-et-Meuse, y compris les Hautes-Fagnes.

Le tableau 2 montre que près du tiers des Elatérides montagnards capurés en Belgique proviennent des Hautes-Fagnes. Tout porte à croire que es Elatérides montagnards se maintiennent d'autant mieux dans un bioope que celui-ci est non seulement suffisamment froid, mais aussi suffisamnent humide.

Ctenicera (Selatosomus) aeneus L. est une espèce subalpine dans le entre et le Sud de l'Europe, mais atlantique dans le Nord (MÉQUIGNON 930; JEUNIAUX 1951).

C. Deux espèces présentent une répartition boréo-alpine (*Ctenicera cupreus* . et *Ct. impressus* F.), et trois autres sont des espèces alpines ou sublpines (*Ct. angustulus* Kiesw., *Ct. virens* Schr. et *Ct. Heyeri* Saxes), qui, en elgique, se trouvent exclusivement dans les Hautes-Fagnes. Il sagit d'espèces qui vécurent dans nos régions à l'époque où sévissait le climat glaiaire, caractérisé comme on le sait non seulement par une température reitivement basse, mais surtout par une humidité très élevée. Au cours du échauffement postglaciaire, ces espèces ont effectué leur migration vers le ord et vers le sommet des montagnes; le plateau des Hautes-Fagnes est la eule région de Belgique qui a pu offrir à ces espèces le climat suffisament humide qu'elles exigent.

D. Neuf espèces présentent une répartition du type atlantique (*Ampedus nguinolentus* Schr.; *Cardiophorus asellus* Er.; *Platynichus equiseti* Hbst.;

P. cinereus Hbst.; *Hypnoïdus quadripustulatus* F., *Melanotus punctolineatus* Pel.; *Limonius aeruginosus* Ol.; *Agriotes aterrimus* L. et *Ctenicera(Sematosomus) nigricornis* Panz.). Elles habitent l'Europe septentrionale, surtout en plaine, dans les marécages, les tourbières, les prairies humides (DU BUYSSON 1910; MÉQUIGNON 1930). Elles sont fréquentes sur la côte belge et en Campine, se trouvent parfois dans la Forêt de Soignes, mais sont inexistantes dans le centre et le Sud du pays, sauf dans les Hautes-Fagnes. Il est évident qu'une telle localisation en Belgique et en Europe est en relation avec un comportement hygrophile très accentué.

E. Dix autres espèces ne peuvent être aisément classées dans les catégories biogéographiques précédentes; leur répartition en Belgique se superpose par contre à ce qui reste des grandes forêts. Ce sont des espèces sylvicoles (*Procraerus tibialis* Lac.; *Ampedus balteatus* L., *A. sanguineus* L., *A. pomorum* L.; *Athous subfuscus* Müll.; *Dolopius marginatus* L.; *Ctenicera purpureus* Poda; *Ct. castaneus* L., *Ct. pectinicornis* L., et *Denticollis linearis* L.).Remarquons que le bois où les larves de ces espèces se développent et se métamorphosent est toujours plus ou moins décomposé et gorgé d'eau (DU BUYSSON 1910; MÉQUIGNON 1930). Le biotope forestier lui-même est le plus souvent franchement humide. Les Elatérides sylvicoles peuvent, donc, en nos régions du moins, être considérés également comme hygrophiles.

F. *Platynichus cinereus* Hbst., *Ctenicera incanus* Gyll. et *Ct. sjaelandicus* Müll. sont des espèces tyrphobiontes, qu'on ne trouve en Belgique que dans les endroits très humides, marais, tourbières, etc.

G. Enfin, neuf autres espèces sont assez communément répandues en Belgique, et l'examen de leur répartition en Belgique et en Europe, ne permet de les ranger dans aucune catégorie biogéographique ni écologique.

Il apparaît donc que la richesse relative des Hautes-Fagnes en espèces différentes d'Elatérides est consécutive à l'existence d'un climat à la fois froid et humide, permettant la cohabitation sur un même territoire d'espèces habitant généralement des régions ou des biotopes bien distincts, mais toujours caractérisés par un degré d'humidité élevé.

2. *Espèces étrangères à la Faune des Hautes Fagnes*

Sur les 29 espèces belges étrangères à la faune des Hautes-Fagnes, 16 sont très rares ou très localisées, presque toutes en Campine ou sur la côte belge; leur capture est occasionelle (moins de 10 spécimens capturés depuis 1950).

Trois espèces sont plus ou moins ubiquistes et ne présentent pas de repartition typique.

Trois espèces ont une répartition du type atlantique, mais sont propres aux terrains sablonneux humides, faciès rare ou inexistant dans les Hautes-Fagnes. Elles sont assez abondantes en Campine et dans la Forêt de Soignes (*Cardiophorus ruficollis* Er., *Hypnoïdus pulchellus* L. et *Ctenicera cruciatus* L.).

Trois espèces sont méditerrannéeennes (*Cardiophorus rufipes* Goeze,

Adrastus limbatus F. et *A. rachifer* Foure). Elles sont fréquentes dans le Sud de la Belgique, le long de la Meuse ou en Lorraine. Le caractère thermophile de ces espèces leur interdit la colonisation des Hautes-Fagnes.

Quatre espèces enfin présentent une répartition continentale en Europe (*Ampedus cinnabarinus* Esch., *A. nigroflavus* Goeze, *Ctenicera cinctus* Payk et *Agriotes ustulatus* Schall.) Les trois prémières sont saproxylicoles. La quatrième est typiquement euryhygre; elle vit dans les terrains secs à végétation rase. Elle est localisée dans les régions les moins humides de Belgique: sud de la Meuse, sud du Hainau Condroz, sud du Luxembourg belge et Lorraine.

Conclusion

On peut expliquer presque toujours la distribution en Belgique et en Europe des Elatérides belges comme étant le résultat de la recherche par ces espèces d'un régime climatique ou de conditions écologiques caractérisées par un degré d'humidité élevé. Quatre espèces d'Elatérides seulement sur 84 présentes en Belgique sont des espèces à répartition continentale, qui ont réagi au climat de la Belgique en espèces euryhygres ou hygrophobes, évitant les régions côtières ainsi que les Hautes-Fagnes, et se cantonnant dans le Centre et le Sud du Pays. Les autres espèces sont soit ubiquistes, soit surtout montagnardes, alpines, atlantiques, ou sylvicoles et tyrphobiontes; elles se sont comportées, au cours du peuplement de la Belgique, en espèces hygrophiles, colonisant principalement les régions les plus humides. Le plateau des Hautes-Fagnes offre des conditions d'humidité telles que non seulement des espèces montagnardes, mais aussi bon nombre d'espèces atlantiques, ou alpines et boréo-alpines peuvent subsister sur son territoire. La rencontre de ces éléments faunistiques à distribution très différente explique la richesse relative de la faune en Elatérides de cette région.

L'ensemble de ces observations nous paraît confirmer largement l'hypothèse de LECLERCQ relatée en tête de ce travail. En ce qui concerne les espèces belges d'Elatérides tout au moins, l'hygropreferendum positif est très général et se manifeste non seulement dans le choix des biotopes colonisés, mais aussi dans le choix des districts géographiques habités. Il est fort possible que la réaction positive au gradient d'humidité soit un caractère physiologique général de la famille des Elatérides.

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DISCUSSION

Mr. **de Beaufort**: Est-il possible que l'espèce *Melanotus punctolineatus* ait eu deux voies de migration, une à l'Ouest le long de la mer et une autre le long des montagnes de l'Europe centrale?

Mr. **Jeuniaux**; On trouve une telle double voie de migration en Europe dans le cas de *Ctenicera (Selatosomus) aeneus* L. Cette espèce est atlantique dans le Nord de l'Europe (Russie, Nord de la Pologne et de l'Allemagne, Hollande, Campine Belge, côte Belge et Sud de l'Angleterre; manque à l'Ouest). Mais elle envahit le Sud de l'Europe par la voie des Alpes (du Tyrol au Piémont). Ces deux voies de migration empruntent des contrées à climat froid et humide. Il est possible que *Melanotus punctolineatus* Pel. ait envahi l'Europe de façon analogue, mais en partant de la Méditerrannée, d'une part en suivant les côtes de l'Océan atlantique et de la Manche, d'autre part, en suivant les Alpes. Cependant, cette espèce manquant totalement en Haute Belgique, sauf dans les Hautes-Fagnes, il est plus vraisemblable que le *M. punctolineatus* des Hautes-Fagnes soit d'origine atlantique.

DIE KÄFERFAUNA DES ANTARKTO – ARCHIPLATAGEBIETES UND IHRE PROBLEME

von

Harald SCHWEIGER

Wien, Österreich *)

Summary

Durch das liebenswürdige Entgegenkommen von Prof. Dr. O. LUNDBLAD erhielt ich das gesamte bisher noch unbearbeitete Koleopterenmaterial zur Determination, welches die Skottsberg – Expedition in Antarkto – Archiplatagebiet aufgesammelt hatte. An Hand dieses Materiales konnte ich unter Zuhilfenahme der ziemlich umfangreichen Literatur folgendes feststellen.

1. Die Koleopterenfauna des behandelten Gebietes setzt sich aus alten, bodenständigen (autochthonen) Formen und jüngeren Einwanderern (Immigranten) aus dem Norden zusammen. Die autochthonen Arten des Gebietes gehören zumeist zu Triben und Genera, die typisch subantarktischen Ursprunges sind (Migadopini, Aepini) und demzufolge auch sehr häufig eine beinahe circumpolare Verbreitung aufweisen. Die Einwanderer dagegen sind andinen oder patagonischen Ursprunges. Die autochthonen Arten sind zumeist alte, starre Formen, die im behandelten Gebiete trotz weitester Verbreitung (*Gypsiella* z.B. von Feuerland bis zum 43° s.Br.) keinerlei Rassenbildung erkennen lassen, während die Immigranten zahlreiche, englokalisierte und zum Teil auch hochdifferenzierte Arten und Rassen ausbilden (*Trechisibius*!).

2. Das Vorkommen von zahlreichen endemischen Arten und Rassen beweist, dass das behandelte Gebiet während der Eiszeit nicht so stark vergletschert gewesen sein kann, wie es gegenwärtig die Geologen annehmen, sondern dass zahlreiche, eisfreie Refugien bestanden haben müssen, in welchen eine sehr artenreiche Fauna persistieren konnte. Im Zusammenhang damit ist es bezeichnend, dass wir auf den Falkland-Inseln noch eine sehr reiche Fauna antreffen, während Südgeorgien und auch andere subantarktische Inseln eine stark devastierte Fauna besitzen.

3. Die Magalhaensstrasse bildet für viele typisch subantarktische Formen die Nordgrenze, während aber umgekehrt zahlreiche Arten andinen Ursprunges diese Barierre zu überschreiten vermochten. Dadurch erscheint uns die Koleopterenfauna des Feuerlandes vom südamerikanischen Festland nicht so verschieden, wie es bei einigen anderen Tiergruppen der Fall ist.

4. Die Fauna der Falkland Inseln weicht vom Feuerland hauptsächlich durch das Fehlen von xylophagen Arten ab und besitzt überhaupt einen mehr steppenmässigen Charakter (kalte Steppe mit Zwergsträuchern). Die wenigen

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typisch patagonischen Arten, die man hier sammeln konnte (*Nictelia, Taurocerastes*) wurden ausnahmslos durch den Menschen importiert (Schafzucht). Von Südgeorgien wurden bisher überhaupt nur strandbewohnende Käfer bekannt, was auf eine postglaziale Rückwanderung der Koleopterenfauna weisen könnte. Dagegen spricht jedoch die Tatsache, dass die Tenebrionidenfauna von Südgeorgien ausschliesslich aus endemischen Formen besteht.

ÜBER DAS HOLARKTISCHE, BOREALE UND ÖSTLICHE FAUNENELEMENT IN DER ZIKADENFAUNA FINNLANDS
(Vorläufige Mitteilung)

von

P.KONTKANEN
Lieksa, Finnland

Die zoogeographische Erforschung der Zikaden (Rhynchota, Auchenorrhyncha) befindet sich noch ganz in ihren Anfängen. Dies rührt daher, dass diese Insektengruppe viel weniger als z.B. die Schmetterlinge und Käfer zum Gegenstand des Sammelns und des Studiums gemacht worden ist. Zweitens ist man in der Zikadensystematik betreffs vieler umfassender Gruppen erst seit den 1920er Jahren zu einer befriedigenden Genauigkeit bei der Artunterscheidung gekommen. Darum sind die älteren Untersuchungen und Kataloge auf weiten Abschnitten unbrauchbar, sofern es auf die Ermittlung der Verbreitung der Arten ankommt. Systematisch korrekte Untersuchungen gibt es vorläufig verhältnismässig wenig.

Aus alledem ergibt sich, dass man bei der zoogeographischen Klärung der Zikadenfauna eines Gebietes noch gar nicht an eine solche Gesamtbehandlung des Materials und detaillierte Genauigkeit der Artengruppierung denken kann, wie man sie z.B. in den bekannten Käferstudien von J. SAINTE-CLAIRE DEVILLE, R. JEANNEL und C.H. LINDROTH verwirklicht findet. Alles nachstehend Angeführte ist daher lediglich als skizzenhafte Aufzeichnungen im Hinblick auf künftige und genauere Untersuchungen aufzufassen.

Was das holarktische Element betrifft, so bietet uns die umfassende und wertvolle Untersuchung OMANs (1949) über die nearktische Fauna eine gute Gelegenheit zu dessen Betrachtung. Da es ein der heutigen systematischen Auffassung entsprechendes Verzeichnis über die Zikaden Europas nicht gibt, mag meines Erachtens wohl auch die Behandlung der Fauna eines enger begrenzten Gebietes förderlich für die Gesamtforschung sein können. Dermassen verschieden im Vergleich zum früheren (HORVATH, 1908, 1912) gestaltet sich unser heutiges Bild von diesem Element.

Von den 286 Zikadenarten der finnischen Fauna sind 41 (14%) auch in Nordamerika zu finden. Von diesen ist nur eine, nämlich *Macrosteles 4-punctatus* (Fall.) [= *dahlbomi* (Zett.)] borealpin. Die südliche Gruppe der nördlichen Arten umfasst zwei Arten, *Macrosteles binotatus* (J. Sahlb.) und *Limotettix paludosus* (Boh.). Die übrigen 38 Arten zeichnen sich durch eine mehr oder minder allgemeineuropäische Verbreitung aus. Bis in die nördlichen Teile des finnischen Lapplands verbreitet sind 9 Arten.

Achorotile albosignata (Dahlb.)	*Arthaldeus pascuellus* (Fall.)
**Calligypona pellucida* (F.)	*Errastunus ocellaris* (Fall.)
**Macrosteles 6-notatus* (Fall.)	*Thamnotettix confinis* (Zett.) (= *simplex* (H.S.))
Balclutha punctata (Thunb.)	*Macustus grisescens* (Zett.)
Deltocephalus pulicaris (Fall.)	

Bis ungefähr in der Gegend von Kuusamo (etwa 66° n.Br.) angetroffene Arten gibt es 7.

Megamelus notula (Germ.)
Calligypona obscurella (Boh.)
**Philaenus spumarius* (L.)
Neophilaenus lineatus (L.)
Empoasca smaragdula (Fall.)
Macrosteles variatus (Fall.)
**Limotettix striola* (Fall.)

Bis hinauf nach Mittelfinnland (etwa 63° n.Br.) gehen folgende 14 Arten.

Euacanthus acuminatus (F.)
E. interruptus (L.)
Typhlocyba ulmi (L.)
Aphrodes bicinctus (Schrk)
**A. albifrons* (L.)
A. flavostriatus (Don.)
Strongylocephalus agrestis (Fall.)
Sagatus punctifrons (Fall.)
Macrosteles viridigriseus (Edw.)
Doratura stylata (Boh.)
Euscelidius schenki (Kbm.)
Streptanus aemulans (Kbm.)
Athysanus argentatus (F.)
Allygus mixtus (F.)

In Finnland typisch südlich (in den meisten Fallen ausserdem deutlich westlich) orientiert sind 8 Arten.

Idiocerus stigmaticalis Lew.
Empoasca bipunctata Osh.
Cicadella stellulata (Burm.)
C. concinna (Germ.)
Typhlocyba froggatti Baker
T. candidula (Kbm.)
T. prunicola Edw.
Paramesus nervosus (Fall.)

Fünf von den Arten dieser mehr oder minder gesamteuropäischen Gruppe (die in den obigen Verzeichnissen mit einem Sternchen bezeichneten) sind bis auf den Azoren gefunden worden. Manche Arten (z.B. *Doratura stylata*) sind offenbar in ziemlich junger Zeit mit dem Warenverkehr nach Nordamerika gelangt.

Wendet man sich sodann dem sog. nördlichen Element im weiteren Sinne zu, so sind da deutlich zwei Verbreitungsgruppen unterscheidbar. Die nördlichere Gruppe (boreale Arten sensu stricto), umfasst nur vier Arten, *Bathysmatophorus reuteri* J. Sahlb., *Macrosteles empetri* Oss., *Psammotettix frigidus* (Boh.) und *Diplocolenus limbatellus* (Zett.), deren Südgrenze ungefähr bei 66° n.Br. liegt; nur *Diplocolenus limbatellus* ist an ein paar Punkten südlicher angetroffen worden.

Zu der südlichere, von mir früher (KONTKANEN 1948, p. 90-91) als das östliche od. Nadelwaldelement unserer Zikadenfauna bezeichneten Gruppe des nördlichen Elements zählen 23 Arten.

Chloriona chinai Oss.
Criomorphus borealis (J. Sahlb.)
C. moestus (Boh.)
Achorotile longicornis (J. Sahlb.)
Calligypona clypealis (J. Sahlb.)
Cixidia confinis (Zett.)
Helicoptera lapponica (Zett.)
Oncopsis planiscuta (Thoms.)
Dikraneura aridella (J. Sahlb.)
Empoasca sordidula Oss.
E. kontkaneni Oss.
E. apicalis (Fl.)
Metalimnus marmoratus (Fl.)
Palus caudatus (Fl.)
P. edwardsi (Lindb.)
P. serricauda (Kontk.)
Limotettix atricapilla (Boh.)
Streptanus confinis (Reut.)
Ederranus discolor (J. Sahlb.)
E. luteus (C.R. Sahlb.)
Elymana kozhevnikovi (Zachv.)
Cicadula intermedia (Boh.)
C. ossiannilssoni Kontk.

Zweifelsohne gibt es dazu auch noch einige vom mitteleuropäischen Standpunkt aus betrachtet mehr oder minder nördliche Arten, die unter sich ihre eigene Gruppe bilden. Auf sie kann indessen hier nicht eingegangen werden.

Eine eingehendere Betrachtung der obenberührten Faunenelemente und Artengruppen wird möglich erst dann, wenn die Zikaden-Bände der „Faune de France" und „Faune de l'URSS" erschienen sind und weit zahlreichere lokalfaunistische Untersuchungen, als die zur Zeit vorliegenden, den Forschern zur Verfügung stehen.

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DISCUSSION

Mr. **De Beaufort**: Ist die Übereinstimmung, die man mit der amerikanischen Fauna findet, bei den finnischen Arten enger im Norden als im Süden?

Mr. **Kontkanen**: Die Übereinstimmung ist im Norden grösser, aber weil es für Canada und Nord-Finnland nicht genug gute Lokalfaunen gibt, ist es bis auf Weiteres unmöglich genaue Vergleiche zu machen. Doch hätte ich a priori eine grössere Gleichheit erwartet.

Mr. **Höne**: Zusätzlich und zum Vergleiche kann ich meine Ermittlungen, auf meine in Ostasien gesammelten Schmetterlinge gegründet, heranziehen. Diese, sowie die Aufzeichnungen des verstorbenen Fürsten A. CARADJA, weisen darauf hin, dass diese Fauna ihren Ursprung im alten Angara-Kontinent gefunden hat.

Mr. **Franz**: Man hat vielfach zwischen den finnischen und schwedischen Populationen südlicher Arten, die das Nordende des Bottnischen Meerbusens nicht erreichen, morphologische Unterschiede festgestellt. Ich frage darum an, ob man solche Unterschiede auch schon bei Zikaden, z.B. in der Morphologie des Genitalapparates hat feststellen können.

Mr. **Kontkanen**: Soviel ich weiss ist diese Frage bei Zikaden nicht untersucht worden. In einigen Artengruppen, deren Mitglieder man nur durch die Genitaluntersuchung unterscheiden kann, kommen im Westen (Schweden) und im Osten (Finnland) verschiedene Arten vor; z.B. *Empoasca viridula* (Fall) in Schweden und *E. paolii* Oss. in Finnland.

BIOGEOGRAPHIE DU GENRE NYCTALEMON DALMAN
(Lepidoptera, Uraniidae)

par

C.O.van REGTEREN ALTENA

Leyde, Pays-Bas

Le genre *Nyctalemon* Dalman est répandu dans les régions tropicales depuis l'Assam jusqu'aux Nouvelles-Hébrides. Dans la littérature on cherche en vain une division satisfaisante de ce genre en espèces et sousespéces (ou races géographiques); celles du „Lepidopterorum Catalogus" et de l'ouvrage de SEITZ par exemple sont absurdes. L'appareil génital ne varie guère et ne peut donc servir de base de classification. Une analyse minutieuse de la variabilité du dessin des ailes m'a mené à la conclusion que ce genre contient trois espèces polytypiques, dont la distribution géographique est indiquée sur la carte.

Les formes du genre *Nyctalemon* habitent la plaine depuis la côte et se trouvent dans la montagne jusqu'à une altitude de 1800 m environ. Plusieurs captures de *Nyctalemon* sur des bateaux en pleine mer indiquent leur penchant au vagabondage qui sans doute est une des causes de l'étendue des territoires occupés par la plupart des races géographiques.

Les deux espèces *N. menoetius* et *N. zampa* occupent la partie occidentale de l'aire de dispersion de ce genre. Elles sont plus proches l'une de l'autre que de la troisième espèce, *N. patroclus*. On pourrait démontrer les relations qui existent entre les races de ces deux espèces de la manière suivante:

$$\begin{tikzcd}
\textit{najabula} & \textit{zampa} \arrow[l] \arrow[dr] & \\
\textit{docilis} \arrow[ur] & \textit{menoetius} \arrow[dl] \arrow[dr] & \textit{dilutus} \\
\text{subsp. n. 2 (Bornéo or.)} \arrow[u] & & \text{subsp. n. 1 (Célèbes)}
\end{tikzcd}$$

Dans la série des cinq races *N. m. menoetius*, *N. m.* subsp. n. 2 (Bornéo or.), *N. z. docilis*, *N. z. zampa* et *N. z. dilutus* on observe une réduction progressive de la bande claire des ailes supérieures. Probablement la distribution géographique de cette série nous montre la direction dans laquelle le genre s'est répandu dans le Sud-est de l'Asie. Cependant il faut supposer que, dans un stade précoce de cette dispersion, les ancêtres de *N. menoetius* et *N. zampa* occupèrent des territoires complètement isolés. ZEUNER (p. 155) a fait remarquer que pendant la période pléistocène le niveau de la mer était temporellement plus élevé qu'à présent. Je suis enclin à placer la séparation des espèces *N. menoetius* et *N. zampa* à cette période. Plus tard, et notamment pendant la dernière période glaciaire dans laquelle le niveau de la mer se trouvait environ 180 m au dessous du niveau actuel, les races *docilis* et *zampa* de *N. zampa* se sont répandues vers l'Est, l'une vers les îles de la

Sonde, l'autre le long de la côte chinoise, peut-être par Formose (quoique ce genre semble ne plus habiter cette île), vers les îles Philippines. Des exemplaires atteignant Célèbes par les îles Sangir furent les ancêtres de la race *N. z. dilutus.* La même route a été suivie par des exemplaires de *N. menoetius* qui furent les ancêtres d'une nouvelle race que j'espère décrire prochainement.

La population de *N. zampa* qui habite les îles Philippines montre des caractères intermédiaires entre les sousespèces *zampa* et *docilis,* quoiqu'elle soit plus proche de la première. Il me semble possible que *N. z. docilis* ait aussi atteint les îles Philippines, par l'île Palawan, et qu'une population mixte existe donc aux Philippines. Cette hypothèse mériterait une vérification par l'analyse profonde d'un matériel beaucoup plus grand que celui que j'ai pu étudier.

N. patroclus habite un territoire qui s'étend des Moluques aux Nouvelles-Hébrides et contient six races géographiques. Je n'ai pas pu trouver de différences entre une petite série provenant de la Nouvelle-Irlande et la race typique qui habite les Moluques. D'autres exemplaires de l'archipel Bismarck sont très proches de la race typique. J'ai voulu d'abord les considérer comme des hybrides, puisque les aires de dispersion de plusieurs races se touchent ici. Cependant il serait possible que la race typique habite toute l'archipel Bismarck (sauf la Nouvelle-Bretagne qui a sa propre race), mais qu'elle y est plus polymorphe qu'aux Moluques.

Le parentage probable des races de *N. patroclus* pourrait être démontré comme suit:

$$
\begin{array}{ccccc}
 & & \text{patroclus} & \longrightarrow \text{mutatus} \longrightarrow & \text{curvatus} \\
 & & | & & \\
\text{kotzenbergi} & \longleftarrow & \text{macleayi} & \xrightarrow{?} & \text{subsp. n. (Nouvelle-Bretagne)}
\end{array}
$$

La série *patroclus - mutatus - curvatus* doit être assez ancienne, vu la spécialisation des races *mutatus* et *curvatus.*

Quoiqu'en general la faune de l'archipel Bismarck et des îles Salomon soit plus voisine de celle de la Nouvelle-Guinée que de celle des Moluques, on connait plusieurs exemples qui indiquent le contraire, par exemple parmi les Oiseaux (*Coracina,* voir RIPLEY; VOOUS & VAN MARLE), les Papillons (*Troides,* voir ZEUNER, p. 150 seq.) et les Libellules (*Rhinocypha,* voir LIEFTINCK). Pour expliquer ce phénomène remarquable ZEUNER (p. 173) a supposé que la Nouvelle-Guinée occupait au début une position plus méridionale et aurait été poussée vers le Nord pendant le Pléistocène en sé-

Fig. 1. Distribution géographique du genre *Nyctalemon* Dalman. Les points indiquent les localités d'où proviennent les matériaux étudiés par l'auteur, les cercles avec croix les localités empruntés à la littérature. 1a: *Nyctalemon patroclus patroclus* (L.); 1b: *N. p. macleayi* (Montr.); 1c: *N. p. kotzenbergi* Pf.; 1d: *N. p.* subsp. (à décrire prochainement); 1e: *N. p. mutatus* (Btl.); 1f: *N. p. curvatus* Skinn. (Nouvelles Hébrides); 2a: *N. menoetius* subsp. 1 (à décrire prochainement); 2b: *N. m. menoetius* Hopff.; 2c: *N. m.* subsp. 2 (à décrire prochainement); 3a: *N. zampa docilis* Btl.; 3b: *N. z. zampa* Btl.; 3c: *N. z. najabula* Mre.; 3d: *N. z. dilutus* Rbr. Les points d'interrogation marquent les localités d'où proviennent des exemplaires d'identité subspécifique douteuse.

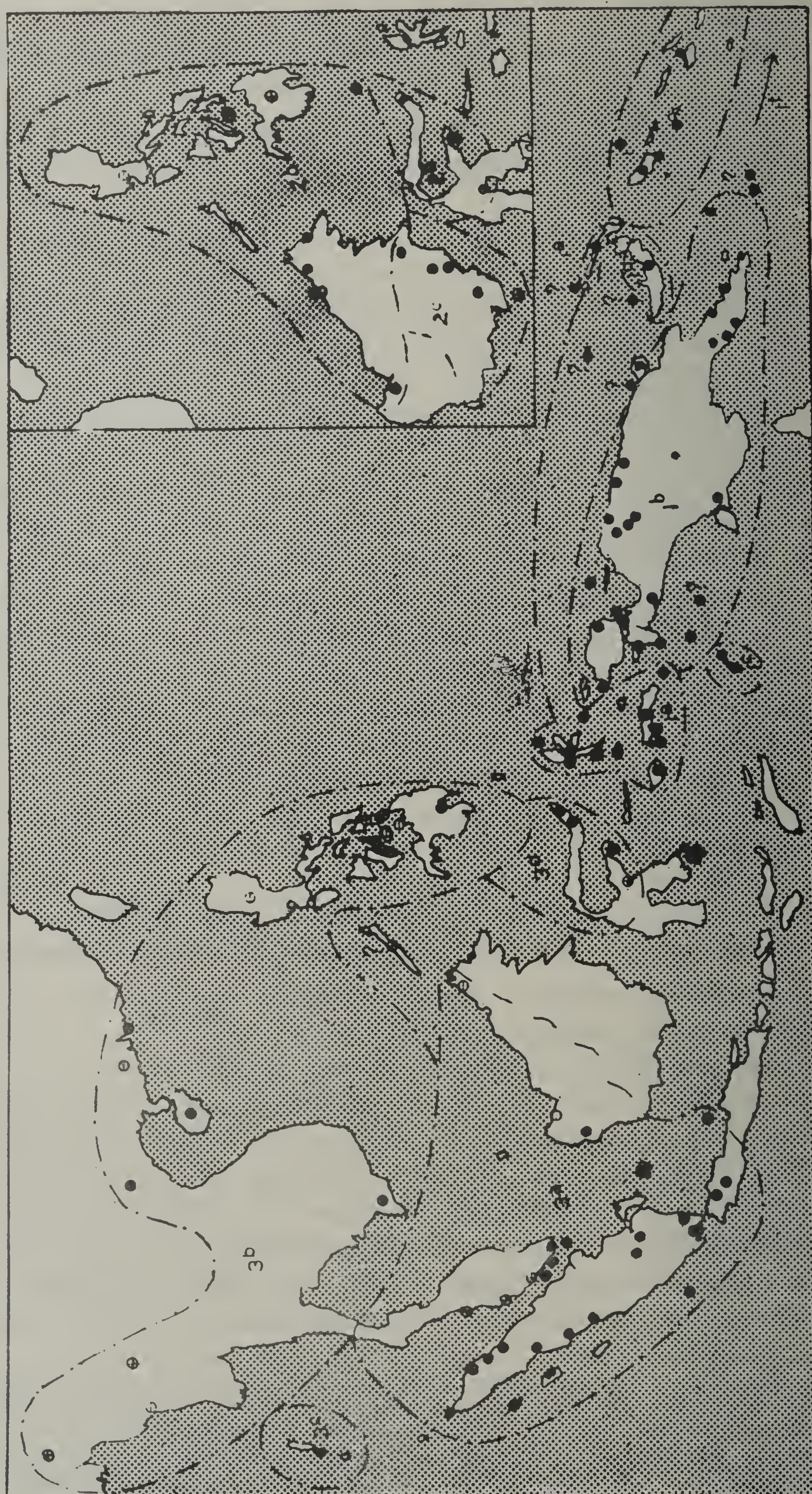

Fig. 1.

parant les Moluques de l'archipel Bismarck.

Il ne me semble pas nécessaire de se servir de cette hypothèse, puisque selon VAN BEMMELEN il y a des indications qu'au Mio-Pliocène un système de montagnes („Melanesian Mountain System") s'étendait de Halmaheira jusqu'à la Nouvelle-Bretagne. La partie centrale de ce système aurait été immergée pendant le Quaternaire, sauf quelques restes qui, à présent, font partie de la région côtière de la Nouvelle-Guinée. Je considère *N.p. patroclus* comme la forme originaire de la partie septentrionale de ce système de montagnes; elle s'est actuellement retirée aux Moluques et à l'archipel Bismarck. La race *macleayi* pourrait provenir de la partie méridionale centrale du même système. Tandis que pendant le Pléistocène la plaine septentrionale de la Nouvelle-Guinée émergait de la mer et la Nouvelle-Guinée prenait sa forme actuelle, *N. p. macleayi* fut mis en état d'envahir l'aire de dispersion immense qu'il occupe à présent. Puisque le genre *Nyctalemon* manque en Australie, il faut supposer que le détroit de Torres ne fût atteint qu'après sa submersion à la fin de la dernière période glaciaire. Des exemplaires traversant la mer aux îles Ténimber furent les ancêtres de la race *kotzenbergi*. La séparation de la race habitant la Nouvelle-Bretagne doit être de date plus ancienne, vu sa spécialisation plus grande.

Par toutes ces considérations, on est porté à chercher l'origine du genre quelque part dans le Nord-est de son aire de dispersion actuelle.

Une révision complète du genre *Nyctalemon* avec une discussion plus detaillée de sa biogéographie et de son évolution, est en préparation.

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DISCUSSION

Mr. **Shoumatoff**: There are species in the New World tropics which in literature are called "*Nyctalemon*". Are they not true members of the genus?

Mr. **van Regteren Altena**: Non, le genre ne se trouve pas en Amerique.

Mr. **Zeuner**: Since the supposed land connection between the Moluccas and the Bismarck Archipelago should have included part of northern New Guinea, should one not expect to find a cline of *Nyctalemon* races Moluccas ⟶ North New Guinea ⟶ Bismarck Archipelago ⟶ Solomons? Since this is not the case, it appears that New Guinea was not in the picture at the time when *N. patroclus* was extending its range eastwards.

Mr. **van Regteren Altena**: Je suis complètement d'accord qu'il reste difficile d'expliquer la présence de la même race aux Moluques qu'à l'archipel

Bismarck, tandis qu'une autre race se trouve en Nouvelle-Guinée, même si on accepte le „Melanesian Mountain System" de VAN BEMMELEN. Mais, j'ai cru que si un tel système existait, il serait possible qu'une race habitait du côté nord, une autre du côté sud de ces montagnes.

Mr. **de Beaufort**: Le genre *Nyctalemon* paraît manquer dans la partie orientale de Java et dans les petites îles de la Sonde. Peut-on attribuer leur absence au climat plus sec qu'ailleurs dans l'Archipel Indo-Australien?

Mr. **van Regteren Altena**: L'absence du genre au Java oriental et aux petites îles de la Sonde pourrait peut-être s'expliquer par l'absence en cette région sèche des plantes dont les larves se nourissent. Malheureusement les données sur la biologie des larves sont beaucoup trop incomplètes pour pouvoir décider cette question.

NEUZEITLICHE FORMEN UNTER DEN LEPIDOPTEREN DER NORDSEEKÜSTEN

von

Georg WARNECKE
Hamburg, Deutschland

Ein in der entomologischen Literatur oft theoretisch erörtertes Problem ist die Frage nach der Schnelligkeit der Evolution, nach der Zeitdauer, die zur Entstehung neuer Formen, Rassen und Arten erforderlich ist. Die Auffassungen gehen weit auseinander, insbesondere auch über die Frage von Neubildungen im Postglazial. Für Schmetterlinge kann jedenfalls nicht bezweifelt werden, dass es sehr schnelle Umbildungen der äusseren Erscheinung gibt. Es genügt, an die seit ca. 100 Jahren zu beobachtende Entstehung und Ausbreitung melanistischer Formen vieler Gross-Schmetterlinge in Mitteleuropa zu erinnern, die bei einigen Arten fast explosionsartig vor sich geht. Auf die Probleme, die mit dieser noch im Fluss befindlichen Erscheinung des sog. „Neomelanismus" verbunden sind, soll aber hier nicht eingegangen werden. Es soll in diesem Vortrag nur auf eine kleine Gruppe von Makrolepidopteren hingewiesen werden, die in auffälliger Veränderung ihres Erscheinungsbildes eine Eigenart der Nordseeküsten bilden und die im Gegensatz zu vielen melanistischen Formen keine Tendenzen zur Ausbreitung zeigen.

Es sind Strandformen. Ihre Zeichnung wird verwaschen oder verschwindet ganz; ihre Färbung wird bleicher, hellgrau oder gelblich. Sie sind dem gelben Sand ausgezeichnet angepasst. Einige dieser Formen sind von den Nominatformen so verschieden, dass sie äusserlich keine Ähnlichkeit mehr miteinander aufweisen. In manchen Bezirken der Küsten des Nordseegebietes sind diese Formen eine ständige Erscheinung; einige überwiegen so stark, dass sich die Nominatformen, die überall im Hinterlande dieser Gebiete fliegen, unter ihnen nur in ganz geringem Prozentsatz finden, so dass die betreffenden Strandformen schon als Lokalformen bezeichnet werden können. Zu beachten ist, dass sie sich ausserhalb des Nordseegebietes entweder überhaupt nicht oder nur ganz vereinzelt unter ihren Nominatformen finden.

Ich gehe zur Aufzählung der einzelnen Formen über und nenne die charakteristischsten zuerst:

1. *Hadena sordida* Bkh. f. *engelhardtii* Duurloo. Grundfarbe gelblichgrau aufgehellt. Zeichnungen z.T. erhalten, bei anderen Stücken verschwindend. Extrem: Die weissgraue, nur noch schattenhaft gezeichnete *lactea* Cock. – England, holländische Inseln und Küsten, ostfriesische und nordfriesische Inseln, in Dänemark nur an der Westküste Jütlands.

Die *engelhardtii*-Form fliegt in manchen Jahren an manchen Stellen (z.B. Jütland, Sylt) in so überwiegender Zahl, dass die Nominatform, die überall

im Hinterlande dieser Küsten vorkommt, darunter fast ganz verschwindet. Die Strandform ist so verschieden, dass der Autor sie s.Z. als neue Art aufgestellt hat.

2. *Miana literosa* Hw. f. *onychina* H.S. Grundfabre gelbgrau aufgehellt, Zeichnungen verschwindend, oft zeichnungslos bis auf die schwach sichtbaren Makeln. Eine ebenso charakteristische Strandform wie *sordida* f. *engelhardtii*, bisher nur bekannt von den holländischen Küsten, den ost- und nordfriesischen Inseln, Helgoland und der Westküste Jütlands, Anscheinend noch nicht in Gross-Britannien gefunden, sicher nicht an den Küsten der Ostsee. Unter der am Strande oft recht häufigen *onychina* fliegt auch die im Binnenlande allein vorkommende violettgraue Nominatform, in manchen Gebieten (z.B. Helgoland, Sylt) nur in ganz geringer Zahl, etwa 2 zu 100. Die Raupe der f. *onychina* lebt im Stengel von *Elymus arenarius*, die Raupe der Nominatform in verschiedenen Gräsern. – Die Artzusammengehörigkeit ist durch Genitaluntersuchungen sichergestellt.

3. *Mamestra albicolon* Hw. f. *cinerascens* Tutt. Grundfarbe hellgrau, Zeichnungen erhalten. – England. In Holland ist sie nach LEMPKE die Hauptform in den Dünengebieten. Ostfriesische Inseln (Borkum, nicht selten). Im Niederelbgebiet nur dunkle Formen. An der Westkuste Jütlands fliegt die hellere Form neben einer dunklen. Im Ostseegebiet sind noch keine hellen Formen gefunden (Abb. 1-6).

Abb. 1. *Mamestra albicolon* Hb. f. *cinerascens* Tutt. ♂ Borkum, 21. VI. 1935 (Struve leg.). Eine Küstenform. 2. *Mamestra albicolon* Hb. f. *cinerascens* Tutt. ♂ Borkum, 17. VI. 1934 (Struve leg.). 3. *Mamestra albicolon* Hb. ♂ Umgebung von Hamburg, Juli 1921. 4. *Mamestra albicolon* Hb. Stark verdunkelt. ♀ Lübeck, 10. VI. 1926. 5. *Hadena sordida* Bhk. f. *lactea* Cockayne (Eine „Strandform"). ♂ Borkum, 1934 (Struve leg.). 6. *Hadena sordida* Bkh. ♀ Hamburg (Sachsenwald).

4. *Agrotis (Euxoa) cursoria* Hfn. f. *obsoleta* Tutt. Gelblichgrau, mit verwaschener bis fast verschwindender Zeichnung. – An allen Küsten der Nordsee, aber in wechselndem Prozentsatz unter den vielen Formen der hier stark variierenden, im Inlande dagegen recht eintönigen Art. F. *obsoleta* ist auch an den Küsten Irlands und an der Ostsee (Brunen) gefunden. Im Katalog von LHOMME werden keine hellen Formen erwähnt. Auf der nordfriesischen Insel Sylt ist bisher nur *obsoleta* festgestellt.

5. *Miana bicoloria* Vill. An den Küsten der Nordsee (auch Ostsee) ist dieser Art nicht mehr zweifarbig, bicolor; das Schwarz bezw. Braun der Innenhälfte der Vorderflügel löst sich auf und es entsteht eine einheitlich wirkende hellere Gesamtfärbung bis zu gelblichen und weisslichen, manchmal nur noch schattenhaft gezeichneten Formen. – Die hellsten Formen kommen fast ausschliesslich an den Küsten der Nordsee, aber auch bis Irland und ganz einzeln an den Küsten der Ostsee, niemals aber im Inland, vor, wo die Nominatform und dunklere einfarbige Formen häufig sind. Die gesammten Strandformen werden zweckmässig unter dem Namen *insulicola* Stgr (alis anticis griseis, albido-nigroque strigulosis) zusammengefasst, weil sie eine einheitliche Entwicklungsrichtung darstellen. Von den französischen Küsten noch nicht bekannt geworden.

6. *Acidalia (Ptychopoda) ochrata* Hb. f. *cantiata* Prout. Eine kleine, nicht rotbraune, sondern mehr schmutziggelb gefärbte Form. – Küste von Kent, Dünengebiete Hollands (PROUT), Insel Borkum. F. *cantiata* ist schon als Lokalform zu bezeichnen. Die nächsten Fundorte der ausgesprochen xerothermen Nominatform liegen am Mittelrhein (Mainzer Becken) und in Pommern (Schwalbenberge bei Graz und Stralsund 1871).

7. *Nola centonalis* Hb. f. *alfkeni* Warn. Vorderflügel einfarbig milchweiss, ohne Binden, Extremform der f. *atomosa* Brem. – Holland (Dünen bei Wijk aan Zee und Zandvoort, nach LEMPKE). Insel Borkum.

Die Bildung aller dieser Formen kann nur im Nordseegebiet selbst erfolgt sein. Sie kommen nur hier (einige hauptsächlich hier) vor. Es sind keine Reliktformen, die anderswo entstanden sein könnten und sich nur hier in besonderen Biotopen gehalten haben. Denn ihre Biotope, Sandstrand der Festlandküsten und Inseln, sind auch ausserhalb des Nordseegebietes weit verbreitet, und ihre Nominatformen kommen dort überall vor, mindestens im nahen Hinterland.

Wenn diese Formen aber im Nordseegebiet entstanden sind, kann ihre Entstehung – erdgeschichtlich gemessen – nur sehr jung sein. Das folgt erstens auch wieder aus der Beschränkung ihrer Verbreitung; denn bei höherem Alter würden diese Formen Zeit gehabt haben, die gleichen Biotope bis Westfrankreich und bis weit in die Ostsee zu besiedeln. Es ist aber bemerkenswert, dass sich an den Küsten Westfrankreichs nur aufgehellte Formen anderer Arten finden. Weiter folgt die rezente Entstehung aus der Geschichte der Nordsee im Diluvium und Postdiluvium. Bryan P. BEIRNE hat 1947 in einem äusserst anregenden und grundlegenden Werk über Herkunft und Geschichte der britischen Macrolepidopteren (Trans. Roy. Ent. Soc. London,

98 p. 273- 372) die These aufgestellt, dass eine grosse Anzahl von britischen Gross-Schmetterlingen hier seit der letzten Interglazialzeit heimisch sei, also die letzte Glazialzeit in bestimmten Gebieten Gross-Britanniens überdauert habe. Er schliesst auf eine interglaziale Einwanderung dann, wenn von einer Art mehrere Formen vorhanden sind, die ein verschiedenes ökologisches Verhalten zeigen und die ferner eine starke Differenzierung von einander getrennter Populationen aufweisen; von mehreren Rassen, wie er sie nennt, sind nach ihm diejenigen am längsten isoliert und daher am ältesten, deren Differenzierung am weitesten vorgeschritten ist. Weitere Gründe für seine Auffassung brauchen hier nicht wiedergegeben zu werden. Diese sonst zutreffenden Ausführungen scheinen mir auf den Spezialfall der von mir behandelten Strandformen aber nicht anwendbar zu sein. So meint BEIRNE von der oben besprochenen *Mamestra albicolon cinerascens*, die er als subspecies, also als geographische Rasse auffasst, dass sie im letzten Interglazial nach Gross-Britannien eingewandert und die letzte Vereisung an den dortigen Küsten überdauert habe, indem sie sich gleichzeitig zu einer endemischen Subspecies herausbildete: postglazial sei dann die

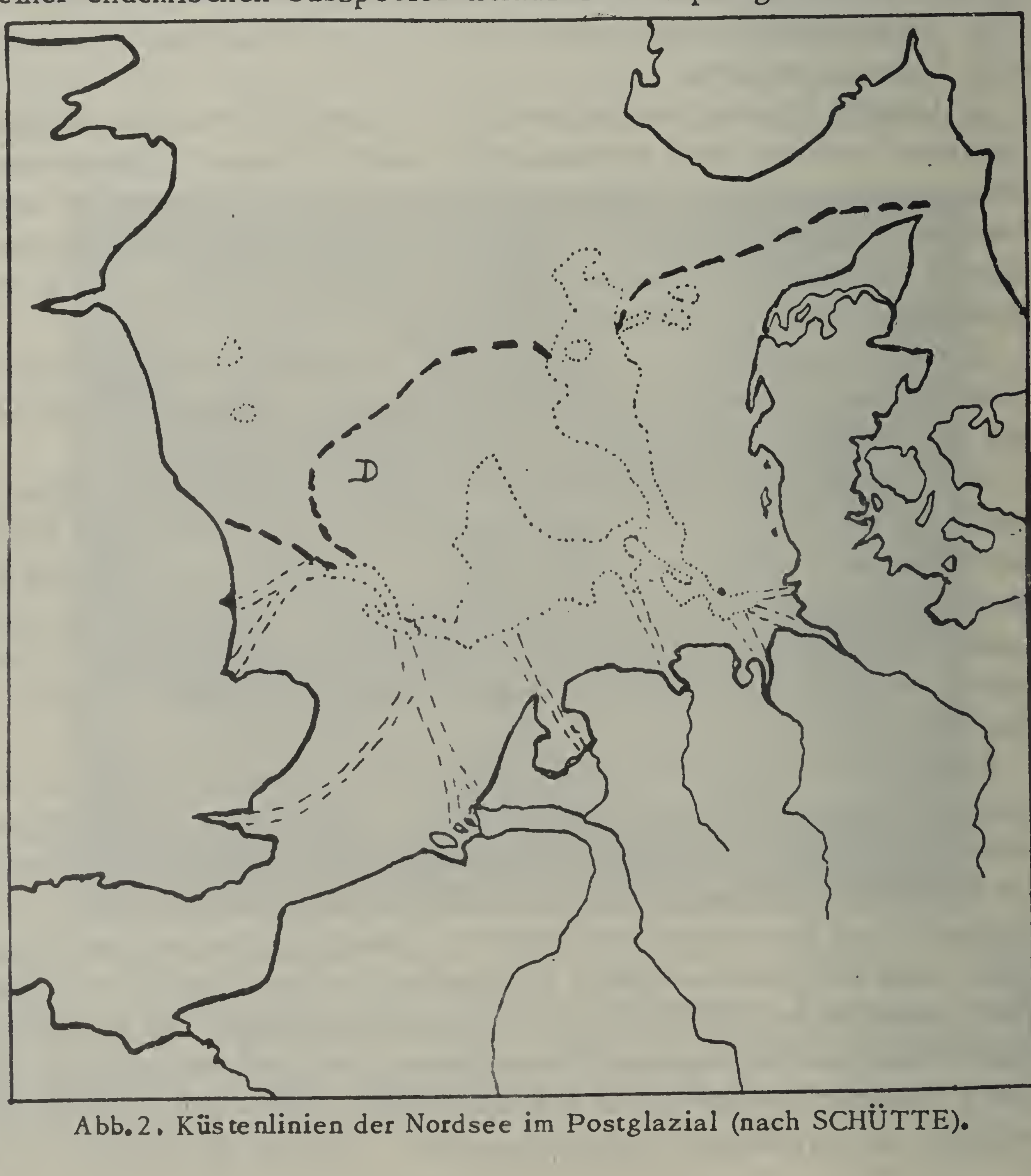

Abb.2. Küstenlinien der Nordsee im Postglazial (nach SCHÜTTE).

Nominatform der *albicolon* gekommen. Ich will nicht darauf eingehen, dass eine scharfe Trennung zwischen *albicolon albicolon* und *albicolon cinerascens* nicht besteht, die Trennung daher nicht alt zu sein braucht. Aber wie hätte sich die Geschichte der *cinerascens* abspielen müssen, wenn sie interglazialer Herkunft wäre? BEIRNE nimmt die Möglichkeit eines Überdauerns während der letzten Vereisung im Vorland der heutigen Küsten von Süd- und Südwestengland (der Meeresspiegel lag damals niedriger) an. In der Tat konnte ein Überdauern im Gebiet der Nordsee selbst nicht stattfinden, denn die südliche Nordsee war damals und postglazial Land, aber ein niedriges Land mit Sümpfen und Mooren, nicht geeignet für Trockenheit und Wärme liebende Arten, wie es diese Strandformen sind. Ich gebe eine Skizze mit der Lage der Küstenlinien der Nordsee im frühen Postglazial. Wenn *cinerascens* in Südwestengland die letzte Eiszeit überdauert hätte, hätte sie erst im späteren Postglazial die holländischen und deutschen Küsten besiedeln können; das würde aber einem weiteren Argument BEIRNEs widersprechen, dass „alte" Rassen sich nicht ausbreiten.

Eindeutig liegt der Fall bei den Formen, die auf die Küsten der Nordsee beschränkt sind, wie *Hadena sordida engelhardtii* und *Miana literosa onychina*. Wo wollten sie, wenn sie „alte" Formen wären, die letzte Vereisung überdauert haben? Die damalige Küste im Doggerbankgebiet war für diese wärmeliebenden Formen kein geeigneter Biotop. In diesem Sumpf- und Moorland dürften übrigens auch Dünen gefehlt haben. Erst nach der Ancyclus-Zeit (7600-5600 v.Chr.), als der Verlauf der heutigen Küstenlinien ungefähr festgelegt war, wird überhaupt erst den beiden Arten *sordida* und *literosa* die Einwanderung in dieses Gebiet möglich gewesen sein. Dann kam erst der Durchbruch des Kanals und die Bildung der Sanddünen. Nun erst waren alle Voraussetzungen geschaffen, unter denen sich an Ort und Stelle diese charakteristischen Sandstrandformen herausbilden konnten. Einige tausend Jahre standen hierfür zur Verfügung. Sie sind als ausreichend anzusehen, denn es darf darauf verwiesen werden, dass sogar die postglaziale Entstehung von guten Rassen bei Wirbeltieren Skandinaviens und Gross-Britanniens nachgeweisen ist.

Es ist unmöglich, im Rahmen eines kurzen Vortrages alle Probleme, die hier in Betracht kommen, auch nur kurz zu erörtern, wie die Frage nach einer polytopen Entstehung dieser Formen, ihrer Entstehung durch Mutation oder Herausmendeln rezessiver Eigenschafen; auch die Eliminationstheorie REINIGS' dürfte Beachtung erfordern. Mutation und Selektion spielen aber gewiss eine Rolle. Indessen sind irgendwelche Untersuchungen, insbesondere Zuchten, noch nicht vorgenommen; die Zucht der meisten Arten ist übrigens nicht leicht.

Wichtig erscheint mir aber noch der Hinweis, dass sich auch bei anderen Arten an den Nordseeküsten Ansätze zur Ausbildung solcher in der Färbung dem Sandstrand angepasster Formen finden, wie z.B. bei *Leucania pallens* L. und ihrer Strandform *favicolor* Barr., bei *Larentia bilineata* L. mit *anaemica* Kautz. Bei anderen Arten sind solche Formen erst in statu nascendi, wie

bei *Agrotis (Euxoa) tritici* L., *Mamestra trifolii* Rott., *Hydroecia fucosa* Frr. – *paludis* Tutt.

Die oft gezogene Folgerung auf ein hohes erdgeschichtliches Alter stark differenzierter Formen von Schmetterlingen erscheint daher als allgemeine Regel nicht begründet. Wie man m.E. auch für das jüngere Postglazial nicht nur mit viel stärkeren Arealverschiebungen rechnen muss, als in der Entomologie bisher im allgemeinen angenommen wird, so muss man auch mit starken Verschiebungen der phänologischen und ökologischen, letzten Endes also der genetischen Struktur rechnen, insbesondere in den Randgebieten der letzten Vereisung. Und es muss zur grössten Vorsicht in der Beurteilung des erdgeschichtlichen Alters gerade bei stark differenzierten Lokalformen gemahnt werden.

DISCUSSION

Mr. **Zeuner:** It is probable that Herr WARNECKE's view is correct, that these forms of Noctuids are of Postglacial age. They are perhaps comparable with adaptive coloration forms as observed in Acrididae, like *Oedipoda coerulescens*. They hardly deserve scientific names, being due either to selection which favours a certain gene in the dune environment or to physiological factors. Such forms can appear at any time under certain environmental conditions. They are unlikely to throw much light on the evolution of species.

Mr. **Franz:** Mit der Bewertung von Farbformen muss man vorsichtig sein. Man findet z.Bsp. in den Alpen in Graben, die während der letzten Eiszeit sicher unter Gletschereis lagen, melanistische Formen, die äusserlich so weit von der Nominatform verschieden sind, dass man sie für eigene Arten halten möchte. Morphologisch besteht völlige Übereinstimmung, höher am Hang und im Haupttal leben normal gefärbte Tiere (z.Bsp. bei *Phyllotreta undulata*). Solche melanistische Formen lassen keinerlei ökologische Beziehungen erkennen und sind wohl am besten als Lokalformen zu bezeichnen.

Mr. **Pasternak:** Eine Antwort auf die Frage, ob Rasse, Subspecies oder Lokalform, können mit Erfolg durchgeführte Zuchten geben; denn sie vermögen die ganze Variationsbreite einer Art aufzuzeigen. Die Ursachen für das verschiedenartige Aussehen gleicher Arten in besonderen Biotopen dürften wohl klimatische Verhältnisse sein. Als Beispiel sei auf das Leinetal bei Alfeld (südl. Hannover) hingewiesen mit seinen zahlreichen Melanismen so verschiedene Boarmien, darunter *B. consonaria* var. *plumbea; Mamestra nebulosa* und *Agrotis stigmatica* in stark verdunkelten Exemplaren, *Demas coryli* var. *melanotica*. Noch auf eine Art sei hingewiesen: *Larentia truncata* die um Alfeld immer selten war und in den letzten Jahren gar nicht gefunden worden ist, dafür aber nur in den Formen *mediorufaria* und *nigerrimata*. Alfeld liegt in einem abgeschlossenen Teile des Leinetales mit besonderen klimatischen Einflüssen.

Mr. **Petersen:** Da man jetzt mehr und mehr den Artbegriff biologisch auffasst, gibt Untersuchung der Genitalien kein Ausschluss, ob zwei Formen eine oder zwei Arten sind. Ob eine Form als eine besondere Subspecies anzusprechen ist, muss immer eine Gefühlssache des betreffenden Autors bleiben. Mit Regeln kann das kaum endgültig geordnet werden.

Mr. **Wiltshire:** 1. Do these "North sea forms" occur at all on the Baltic Sea Coast? 2. Would Mr. WARNECKE give his opinion regarding the origin of *Arenostola elymi?*

Mr. **Warnecke:** 1. Diese „Nordseeformen" sind bisher im Gebiet der Baltischen See entweder überhaupt noch nicht (z.B. *Hadena sordida engelhardtii)* oder nur als äusserste Seltenheit gefunden, wahrend das Charakteristikum für das Nordseegebiet gerade ihre Häufigkeit bez. ihr fast völliges überwiegen über die Nominatformen ist.

2. Die im Nord- und Ostseegebiet an die Küsten gebundene *Ar. elymi* (Raupe in Elymus etc.) ist wohl ein altes Steppenelement aus Asien, das wie z.B. *Agrotis ripae* Hb. seine Biotopansprüche nur noch an den Küsten erfüllt findet. In Finnland kommen viel dunklere Formen vor als im Nordseegebiet (*saturatior* Stgr).

PROBLEMES ZOOGEOGRAPHIQUES POSES A L'OCCASION D'UNE MONOGRAPHIE DES HYMENOPTERES CRABRONIENS

par
Jean LECLERCQ
Liège, Belgique

Nous avons actuellement en préparation une monographie de la sous-famille des Crabroninae (Sphecidae) comportant notamment la discussion des caractères utilisables pour étudier les affinités des lignées, le tableau dichotomique des 31 genres connus, et le catalogue des 700 espèces valablement décrites à ce jour. Cette monographie comprendra aussi un chapitre zoogéographique dans lequel seront détaillées, classées et discutées toutes les informations relatives à la distribution des genres, des sous-genres et des espèces.

L'intérêt des Crabroniens au point de vue zoogéographique réside d'abord dans le fait qu'il s'agit d'un groupe évolué qui ne doit pas, ou guère, être antérieur à l'Eocène. Il réside aussi dans le fait que ce groupe est très homogène au point que des taxonomistes comme F.F.KOHL et G.ARNOLD se sont naguère refusés à y voir plus d'un ou de deux genres réels. Dans ces conditions, on peut considérer comme faibles les chances pour des groupes d'espèces présentés comme apparentés par les taxonomistes, d'être en réalité des ensembles hétéroclites correspondant à l'aboutissement de convergences trompeuses.

Nous avons résumé pour cette note quelques points qui présentent un intérêt biogéographique général; nous renvoyons à la monographie pour l'exposé détaillé des faits et de l'argumentation.

Il en est des Crabroniens comme de la plupart des organismes: la répartition des formes actuelles ne peut s'expliquer en considérant exclusivement a) les barrières, les voies d'échange et les grands faits climatiques de la nature contemporaine, b) l'influence des glaciations quaternaires et c) d'éventuels et improbables passages fortuits au travers des mers et des océans. Ces éléments ne peuvent par exemple expliquer pourquoi:

a) tous les genres et près de la moitié des sous-genres paléarctiques sont aussi présents en Amérique du Nord;

b) il y a plusieurs espèces distribuées suivant le mode holarctique;

c) il n'y a en Amérique boréale que trois genres qui ne se retrouvent pas en Eurasie mais bien en Amérique néotropicale tandis qu'il y a en Amérique néotropicale neuf genres qui n'existent pas dans la Région Néarctique;

d) un groupe de genres très voisins compte deux genres américains, deux genres orientaux et un genre sud-africain („*Foxita* Complex");

e) un groupe de genres voisins compte des représentants dans toutes les

régions du globe à climat tropical ou de type méditerranéen (groupe *Entomocrabro-Lindenius);*
f) il y a des ressemblances certaines entre les éléments australiens et néotropicaux non strictement inféodés au climat intertropical, ces ressemblances allant jusqu'à la possession en commun d'un genre et d'un sous-genre (*Podagritus* subg. *Echuca)* qui ne vivent nulle part ailleurs sur le monde;
g) il y a des ressemblances certaines entre des éléments orientaux et américains qui ne sont probablement pas inféodés au climat intertropical, ces ressemblances allant jusqu'à la possession d'un sous-genre commun (*Crossocerus* subg. *Yuchiha*) dont les parents les plus proches sont ou bien holarctiques (*Hoplocrabro*) ou bien sud-africains (*Pericrabro* et *Microcrabro*).

On pourrait être tenté d'expliquer toutes ces particularités en faisant appel à la théorie wegenerienne des translations continentales ou en imaginant toute une série de ponts transatlantiques et transpacifiques aujourd'hui effondrés. Mais les géologues et les paléontologues ont de sérieuses objections à formuler à l'égard de ces théories et surtout à leur application aux temps tertiaires (G.G.SIMPSON, 1940, 1943, 1947; P.FOURMARIER, 1940, 1950; J.H.F.UMBGROVE, 1946, 1947). Le zoogéographe doit être prudent et doit s'abstenir de baser ses reconstitutions sur des hypothèses plus fragiles que ses conceptions sur les affinités des organismes. C'est pourquoi nous avons fait nôtre ce point de vue adopté de plus en plus par les spécialistes de la géographie et de la paléontologie des Vertébrés, point de vue que K.P.SCHMIDT (1946) formule comme suit: „zoogeographic hypotheses should be based upon geological facts, and not geological hypotheses upon zoogeographic facts".

Il est d'ailleurs patent que la répartition moderne des Crabroniens peut très bien s'interpréter en ne faisant appel qu'à des voies d'échanges reconnues comme certaines, ou comme probables, ou au moins comme des possibilités, par les géologues contemporains (P.FOURMARIER, 1940, 1950; R.W.FAIRBRIDGE, 1949). Nous n'insisterons pas ici sur les phénomènes géologiques et géographiques qui ont conditionné au cours du Tertiaire et du Quaternaire les échanges entre les deux Amériques via l'isthme de Panama, ni entre l'Eurasie et l'Afrique via le Sahara et le N.E. de l'Afrique, ni entre la Région Orientale et l'Océanie à travers la ligne de WALLACE. Les Crabroniens ne fournissent à ces sujets que des faits complémentaires à ajouter aux éléments classiques qui ont justifié la délimitation des grandes régions zoogéographiques dans les systèmes de SCLATER et WALLACE et de LYDEKKER.

Par contre, les deux interprétations suivantes seront retenues parce qu'elles démontrent qu'on peut rendre compte des faits zoogéographiques en adoptant la théorie de la permanence des continents et des océans, amendée sans faire violence aux faits établis par la géologie et la paléontologie.

A. Echanges entre la Région Néotropicale et l'Australie par une voie antarctique

Il est impossible de comprendre la présence d'un même sous-genre en Australie et en Amérique du Sud (*Podagritus* subg. *Echuca*) et la présence en Australie de genres (*Piyuma, Chimiloides*) apparentés essentiellement à des genres exclusivement néotropicaux (*Taruma, Chimila*), sans faire passer leurs ancêtres respectifs par une voie australe. L'hypothèse d'un développement par convergence doit être exclue car il s'agit d'une parenté très étroite entre espèces et entre genres. Nul taxonomiste n'hésiterait à grouper côte à côte les éléments australiens et néotropicaux. Si on présentait à un spécialiste de Crabroniens un *Podagritus(Echuca)* non décrit, dépourvu d'étiquette de provenance, il lui serait très difficile, voire impossible d'affirmer qu'il s'agit d'une espèce australienne plutôt que d'une espèce néotropicale. Il faut aussi exclure l'hypothèse d'un refoulement à partir d'une distribution préalablement plus septentrionale. En plus des arguments invoqués notamment par K.ANDER (1942) pour d'autres cas semblables, il convient de noter que:

1) Ces genres font partie de groupes homogènes, relativement proches des formes ancestrales. Leur centre de dispersion n'a pu se trouver qu'en Amérique du Sud, puisque c'est là que vivent le plus de genres, le plus de sous-genres et le plus d'espèces de lignées apparentées. Seul, le genre *Rhopalum*, proche des *Podagritus*, a une distribution moderne étendue à tous les continents et pourrait être considéré comme un genre qui admet la règle „age and area" de J.C.WILLIS (1922). Mais c'est encore en Amérique du Sud qu'il est le plus riche en espèces variées. Tous les autres éléments apparentés aux genres considérés sont ou bien exclusivement australiens, ou bien exclusivement néotropicaux, ou à peine représentés en bordure des deux régions considérées; aucun n'habite l'Afrique ou la Région Paléarctique.

2) Les *Podagritus* sont des insectes peu tolérants vis-à-vis de la chaleur. On ne les rencontre aux latitudes intertropicales qu'à des altitudes élevées de l'ordre de 1000 à 3000 m. Les *Podagritus* (*Echuca*) n'ont pas été rencontrés au Queensland septentrional, alors que c'est là une des parties de l'Australie qui a été la mieux explorée pour ses Crabroniens. Imaginer que ce sous-genre serait venu d'un centre septentrional serait lui imposer, sans preuves, le franchissement par deux fois de la barrière climatique permanente constituée par l'Equateur calorique. Ce serait lui imposer le franchissement de cette barrière dans la Région Orientale, où ont aussi existé des obstacles géographiques pendant tout ou presque tout le Tertiaire. Ce serait postuler son extermination systématique dans des parties du monde qui ont toujours, même au Pleistocène, conservé des zones à climat compatible avec ses exigences spécifiques.

3) Il est en outre hautement invraisemblable que les éléments considérés aient habité au Tertiaire l'hémisphère nord et en aient été éliminés sans laisser de traces, même pas en Afrique du Sud. On sait que les Insectes ne

se sont pas concurrencés au même titre que les Mammifères Placentaires et les Marsupiaux. S'il fallait invoquer un refoulement imposé par l'apparition des derniers venus des Crabroniens, on ne comprendrait pas pourquoi les genres en question sont restés plus nombreux et plus variés en Amérique du Sud qu'en Australie, alors qu'en Amérique du Sud, les lignées les plus récentes et les plus évoluées, originaires du nord, se sont introduites incomparablement plus nombreuses qu'en Australie.

Il est par ailleurs facile d'expliquer pourquoi les ressemblances entre les faunes australienne et néotropicale de Crabroniens se bornent aux cas précités et ne s'étendent pas à un plus grand nombre d'éléments:

a) Nous ne savons pas quelle fut exactement la nature de la connection terrestre Patagonie-Australie, il est possible qu'elle consista simplement en chaines d'îles assez rapprochées ou en un isthme étroit. Il est certain que ces connections furent rompues assez tôt au Tertiaire (dès la fin du Miocène).

b) Le climat de la Paléantarctide a évolué à partir d'un régime subtropical ou tempéré chaud vers un régime de plus en plus froid. Une barrière climatique a pu donc s'opposer à l'échange des éléments strictement inféodés au climat tropical comme nombre de ceux qui habitent actuellement les régions équatoriales d'Australie et d'Amérique du Sud.

c) Il est possible, comme le proposent R.FURON (1941), R.JEANNEL (1942), etc., que l'Amérique du Sud fut au début du Tertiaire partagée en deux ou trois masses terrestres séparées par l'Océan.

B. Echanges entre l'Ancien Monde et le Nouveau Monde par une voie nord-pacifique

La voie de migration nord-pacifique est probablement l'une des connections terrestres du Tertiaire des moins discutables. Elle suffit à rendre compte des migrations tertiaires et quaternaires des Mammifères (G.G.SIMPSON, 1947). Il est possible qu'une voie nord-atlantique fut aussi utilisée au début du Tertiaire, mais aucun élément tiré de l'étude zoogéographique des Crabroniens n'en réclame l'intervention.

On a discuté pour savoir si le climat tertiaire du nord du Pacifique ne fut pas trop froid pour assurer le passage des animaux. Remarquons qu'il n'est nullement prouvé que le Pôle Nord ait jamais occupé une place aussi différente de celle d'aujourd'hui que ne le voulaient KÖPPEN et WEGENER (cf. F.E.ZEUNER, 1950) et J.H.F.UMBGROVE (1946) a montré que cette hypothèse de la migration des Pôles est en opposition avec nombre de faits géophysiques. Enfin les phytopaléontologues attribuent aux territoires qui avoisinent actuellement l'isthme de Behring, une flore tertiaire du type tempéré.

Sachant que le climat s'est en tous cas progressivement refroidi au nord du Pacifique, on peut s'attendre à ce que les échanges entre l'Ancien et le Nouveau Monde aient comporté toutes les phases entre le passage de lignées thermophiles (qu'on retrouve actuellement à des latitudes intertropicales ou subtropicales) et le passage de lignées peu thermophiles qui trou-

vent leur optimum dans les régions de climat tempéré froid. En fait la comparaison des faunes des différentes zones climatiques de l'Ancien et du Nouveau Mondes montre que les zones intertropicales ont assez peu en commun (aucune espèce, peu de sous-genres, quelques genres), les zones soumises à un climat du type méditerranéen ont un peu plus en commun (aucune espèce mais plusieurs sous-genres et la plupart des genres) tandis que les zones tempérées ont beaucoup en commun (plusieurs espèces holarctiques, beaucoup de sous-genres holarctiques, presque tous les genres en commun). Cela suggère évidemment que les échanges d'éléments thermophiles furent antérieurs aux échanges d'éléments adaptés au climat tempéré.

Si donc on classe les Crabroniens qui ont dû effectuer une migration d'un monde à l'autre, en se basant sur le degré décroissant de leur thermophilie probable (celle-ci étant déterminée d'après les conditions climatiques de leurs habitats actuels), on a beaucoup de chances d'arriver ainsi à l'ordre probable dans lequel les migrations ont dû se succéder. On arrive au résultat suivant pour les sous-genres holarctiques de *Crossocerus*, suffisamment nombreux pour permettre des comparaisons:

a) sous-genre thermophile tropical et subtropical (*Yuchiha*);

b) sous-grenre de la région tempérée qui n'habite ni les latitudes boréales, ni les altitudes élevées des hautes montagnes (*Hoplocrabro*);

c) sous-genres de la région tempérée dont certaines espèces habitent les latitudes boréales et les altitudes élevées des hautes montagnes, cités en partant du sous-genre qui compte proportionnellement le moins d'éléments boréo-alpins ou alpins et le plus de formes méditerranéennes ou sonoriennes, pour arriver au sous-genre qui compte le plus d'éléments alpins et boréo-alpins et le moins de formes méditerranéennes et sonoriennes: *Crossocerus*, *Ablepharipus*, *Coelocrabro*.

Il est remarquable que l'ordre des migrations ainsi reconstitué correspond parfaitement à celui qu'on obtiendrait en classant ces mêmes sous-genres suivant leur degré de spécialisation morphologique, éthologique, etc., c'est-à-dire suivant leur ancienneté probable.

Toutes ces observations s'accomodent très bien de la thèse qui ferait passer toutes les migrations de Crabroniens holarctiques par une voie unique, accessible pendant presque tout le Tertiaire et une partie du Quaternaire, laquelle se serait refroidie progressivement et aurait bénéficié d'un climat tempéré vers la fin de son intervention.

La difficulté qui subsiste consiste à savoir si la voie nord-pacifique eut jamais au début du Tertiaire un climat suffisamment chaud pour permettre l'expansion de lignées dont les descendants modernes sont localisés dans des aires à climat de type méditerranéen ou tropical (par exemple les ancêtres des *Lindenius*, *Encopognathus*, *Arnoldita*, *Vechtia*, etc.).

Cette difficulté n'est peut-être pas aussi grande, ni aussi définitive qu'on pourrait le croire. Tout d'abord, il est certain que les éléments qui ont dû emprunter l'itinéraire nord-pacifique étaient différents taxonomiquement de leurs descendants actuels (aucune espèce et très peu de sous-genres étant

communs aux parties chaudes des deux mondes). E.MAYR (1946) s'est trouvé devant un problème identique au sujet de certains Oiseaux pantropicaux et a formulé toute une série d'hypothèses qu'il y aurait lieu d'envisager préalablement. Il est d'abord possible, comme le suggère aussi R.MALAISE (1945), que la connection terrestre nord-pacifique fut au Tertiaire bien plus étendue vers le sud que les terres qui en subsistent actuellement de part et d'autre du détroit de Behring. Il est aussi possible que les formes qui empruntèrent cette voie au début du Tertiaire furent sensiblement plus eurythermes que leurs descendants actuels. Cela ne serait pas surprenant pour les Crabroniens car ces insectes sont dans l'ensemble relativement eurythermes et ne paraissent pas trouver leur optimum dans les régions les plus chaudes de la terre. De plus tous les genres thermophiles incriminés sont parents d'autres genres qui comptent des formes modernes beaucoup plus septentrionales. Enfin, on pourrait aussi chercher à savoir si les éléments intertropicaux et subtropicaux sont effectivement aussi thermophiles que le suggère leur localisation géographique.

Quoiqu'il en soit, ces éventualités ont au moins l'avantage de maintenir le problème sur le terrain du vérifiable. Il serait conforme à la méthode scientifique de les examiner de plus près avant de se croire obligé de spéculer sur l'existence d'hypothètiques connections transatlantiques ou transpacifiques qui soulèveraient plus de problèmes qu'elles n'en résoudraient.

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DISCUSSION

Mr. **de Beaufort:** 1. Est-on renseigné sur les moyens de dispersion des Crabroniens? 2. Les formes qui habitent l'Amérique du Sud et l'Australie sont elles plus primitives que les autres? 3. Je suis d'accord avec M. LECLERCQ que la température du „pont Behring" a été assez élevé pour permettre la migration des Crabroniens.

Mr. **Leclercq:** 1. On ne trouve presque jamais d'Hyménoptères Aculéates dans le „plankton aérien". Le genre de vie des Crabroniens et la faiblesse numérique des populations de ces insectes sont tels qu'il est improbable que leur dispersion puisse se faire normalement par le vent, à travers les océans. Les différences entre les faunes côtières d'Europe et d'Amérique, et aussi des faunes britannique et européenne confirment cette thèse. 2. Les formes qui habitent exclusivement l'Australie et l'Amérique du Sud appartiennent à des branches relativement primitives de l'arbre phylogénétique des Crabroniens, mais ce ne sont pas les plus primitifs des Crabroniens actuels.

SECTION VIII

AGRICULTURAL ENTOMOLOGY AND BEEKEEPING

BIOLOGIE ET METHODES DE LUTTE CONTRE LE PSYLLE DU POIRIER (Psylla pyri L.)

par
L. BONNEMAISON et J. MISSONNIER
Versailles, France

Dans la région parisienne, *Psylla pyri* L. est beaucoup plus commun que *Psylla pyrisuga* Först. et *Psylla pyricola* Först; nous avons étudié la biologie de *Psylla pyri* L. et les moyens de lutte les plus efficaces.

Les trois espèces présentent deux formes: une forme estivale et une forme hivernale, qui peut résister à des froids rigoureux. Cette forme hivernale a une coloration plus sombre que la forme estivale; sa taille est un peu plus grande; les nervures des ailes sont brunes et plusieurs cellules présentent des zones enfumées. Ces formes hivernales ne s'observent que parmi les insectes dont la mue imaginale a lieu après le début de septembre.

Les formes estivales pondent 5 à 8 jours après la dernière mue alors que les formes hivernales, placées dans les mêmes conditions de milieu, ne commencent à se reproduire que plusieurs semaines après la mue imaginale.

L'apparition de ces formes hivernales n'est pas dûe à la maturité de la plante, ainsi qu'on l'admet généralement; elle présente les plus grandes similitudes avec l'apparition des formes sexuées chez les Aphidinae (2-4). Nous avons pu obtenir à volonté des formes estivales ou hivernales en faisant agir une lumière naturelle ou artificielle d'une durée de 12 h. sur des poiriers placés dans un local où la température n'excédait pas 18°; il est possible d'obtenir plusieurs générations successives de formes estivales ou de formes hivernales mais on peut réaliser expérimentalement plus facilement la production de formes hivernales dans la descendance de formes estivales que parmi la progéniture de formes hivernales.

Les insectes adultes hivernent sous les écorces des arbres fruitiers ou forestiers ainsi que sous les pierres et les feuilles mortes; les larves et les adultes de la forme estivale sont tués par le froid. Les hivernants circulent sur les rameaux par les journées ensoleillées de l'hiver et piquent les branches les plus jeunes. L'accouplement a été noté pendant le mois de novembre et dès la fin du mois de janvier. Les ovaires s'accroissent au cours du mois de janvier et la ponte peut commencer à la fin de ce mois mais les larves les plus précoces ne peuvent s'alimenter, les bourgeons des Poiriers étant insuffisamment développés au moment de l'éclosion.

Les pontes importantes sont notées à partir du début de mars; les oeufs sont d'abord déposés isolément ou en groupes de 2 à 7 à la base des bourgeons a fleurs ou à bois puis, en nombre plus élevé, sur les écailles et les jeunes feuilles et enfin en files sur les pédoncules floraux et de part et d'autre de la nervure principale des feuilles. Les Psylles hivernants meurent

généralement avant la fin du mois de mai, quelques jours après l'émission des derniers oeufs; la fécondité varie d'une centaine à près de 500 oeufs.

Les oeufs ne peuvent se développer que sur des tissus végétaux turgescents; les larves aux 1er, 2ème et 3ème stades se tiennent de préférence à la face inférieure des feuilles et baignent dans une gouttelette de liquide sirupeux et limpide; parvenues au 4ème stade, elles abandonnent la feuille et vont se fixer sur les jeunes rameaux, le pédoncule et le calice des fruits ainsi que sur les „dards".

Les adultes de la première génération apparaissent à la fin du mois d'avril et dans le courant du mois de mai. Suivant les conditions climatiques de la fin du printemps et de l'été, il peut y avoir dans la région parisienne 4 ou 5 générations. Les larves peuvent poursuivre leur développement tant que la température n'est pas trop rigoureuse; certaines d'entre elles peuvent devenir adultes au cours de la première quinzaine de décembre.

Les dégâts cocasionnés par les Psylles varient dans de très fortes proportions; d'une façon générale, ces insectes sont peu nombreux jusqu'à la fin de juillet. WILLE (1950) a signalé la présence en Suisse de plusieurs parasites et prédateurs des larves et des adultes de Psylles; aux environs de Paris, les agents biotiques sont peu actifs ce qui explique l'importance des dégâts qu'ils peuvent occasionner. Le miellat provoque des brûlures du feuillage et le développement de la fumagine sur les feuilles et les fruits ce qui déprécie fortement la valeur de ces derniers; il se produit parfois une chute partielle du feuillage dans le courant du mois d'août. Par leurs piqûres, les larves et les adultes épuissent les arbres et diminuent la récolte.

Méthodes de lutte

Les traitements d'hiver ne peuvent avoir qu'une efficacité des plus limitées en raison de la variété des lieux ou les Psylles s'abritent durant la mauvaise saison.

Les traitements réalisés au cours de l'été ne sont pas recommandables ils ne peuvent atteindre qu'une faible proportion des larves ou des adultes en raison de la densité du feuillage et détruisent les párasites naturels des Psylles et d'autres insectes, notamment des Aphides (3).

Les traitements d'automne sont beaucoup plus intéressants; ils sont faits après la récolte des fruits (vers la mi-octobre dans la région parisienne) et permettent d'atteindre les dernières pontes, les larves et les adultes, avant qu'ils n'aient gagné leurs abris d'hiver.

L'huile blanche d'été, pure ou additionnée de nicotine ou de roténone, le D.D.T. en émulsion, le Pyrophosphate de tétraéthyle sont insuffisamment actifs. Par contre, le coefficient d'efficacité, calculé d'après la formule d'ABBOTT, a été de 98 à 100 % avec des pulvérisations d'H.C.H. en émulsion renfermant 36 g. d'isomère gamma par hl., le thiophosphate de diéthyl et de paranitrophényl en suspension à 22 g. de M.A. par hl., ou en émulsion à 14 g. de M.A. par hl. ou un mélange d'huile blanche d'été et de Thiophosphate à 15 g. de M.A. par hl. Ces traitements d'automne permettent égale-

ment de détruire les sexupares et les femelles sexuées de pucerons (3).

Les traitements de printemps doivent être faits à un moment ou ils permettent de lutter contre plusieurs ravageurs; ils sont à réaliser de préférence lorsque 50% des bourgeons des variétés Passe-Crassane, Doyenné d'hiver, Beurré Diel sont parvenus aux stades D3 à E d'après la notation de FLECKINGER (6) c'est-à-dire au moment où les boutons floraux sont presque complétement verts et accolés les uns aux autres ou séparés de 1 mm. au maximum; il est ainsi possible de détruire la Cécidomyie des Poirettes (1-7) ainsi que les oeufs, les larves et les adultes de Psylles et en outre, les chenilles de Tordeuses les plus précoces, les larves de Calocoris et les fondatrices des pucerons du Poirier. Les insecticides les plus recommandables sont les esters thiophosphoriques et l'isomère gamma de l'H.C.H. En raison de leur précocité, ces traitements ne peuvent entrainer la mort des parasites ou des prédateurs des ravageurs les plus communs du Poirier.

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DISCUSSION

Mr. **Bovien**: Has the species *Psylla pyrarboris* SULZ. been found to be a pest in France?

Mr. **Bonnemaison**: Non.

Mr. **Geier**: Le conférencier a-t-il entrepris des essais de lutte contre *P. pyri* au moyen d'insecticides du type „systémique"?

Mr. **Bonnemaison**: Il n'a pas été fait d'essais en plein air avec les insecticides systémiques en raison du prix élevé de ces derniers et de la nécessité de traiter au moment où le feuillage est suffisament développé. Les expériences faites à très petite échelle semblent montrer que ces produits sont d'une efficacité limitée.

Mr. **van Dinther**: 1. Le conférencier peut-il citer les parasites et les prédateurs observés en France? 2. Quelle est l'importance numérique relative de ces derniers?

Mr. **Bonnemaison**: Les parasites et prédateurs sont rares dans la région parisienne. Il n'a pas été observé, pour le moment, d'espèces exercant un rôle quelconque sur la pullulation des psylles.

Mr. **de Fluiter**: Est ce qu'est vrai que l'apparition des formes estivales et hivernales est sous la dépendance de la température et de la longueur du jour, comme c'est le cas chez les aphides? Et quelles sont les conditions qui inducent le début de ces formes?

Mr. **Bonnemaison**: L'apparition des formes hivernales et estivales est sous la dépendance étroite de la lumière et de la température; l'apparition des formes hivernales présente un grand parallelisme avec celle des formes sexuées chez les Aphidinae (durée de lumière inférieure à 13 - 14 h, température inférieure à 18 - 20°). L'apparition des formes estivales est sous la dépendance de facteurs comparables à ceux qui régissent la production des formes parthénogenétiques.

INSECT PESTS OF CULTIVATED RASPBERRIES IN SCOTLAND

by
A.R.HILL
Glasgow, Scotland

The climatic and soil conditions of the midland valley of Scotland are admirably suited for the cultivation of raspberries. At present the total acreage is approximately 7.000 acres, Perthshire and Angus being the most important counties.

The number of species of insect pests attacking raspberries is small but the degree of damage which they are capable of perpetrating is often disasterously high. Six insect species are listed as serious pests – *Byturus tomentosus*, F.; *Otiorrhyncus singularis*, L.; *Lampronia rubiella*, Bjerk.; *Lygus pabulinus*, L.; *Amphorophora rubi*, Kalt.; *Doralis idaei*, V.d.G. All are universally distributed throughout the area in question.

Adults of the beetle *B. tomentosus* become active in late May and when abundant swarm in large numbers over the trusses of unopened flower buds on which they feed. Such flower buds as survive this onslaught serve as places for oviposition and the larvae which hatch from the eggs spend most of their larval life burrowing through the fleshy receptacle of the berry. This may have the effect of disfiguring the fruit and even preventing its development. To those interested in canning, this infestation is particularly important for the larvae have the unfortunate habit of floating to the surface of the syrup in the can where they form an unsightly and disgusting scum.

The usually recommended control measures against the beetle – Derris sprays – give excellent control if properly applied, i.e. if applied in the correct quantity at the right time. However, many Scottish growers complained that they had very uneven results from the use of Derris and it was not surprising that numbers of them turned to D.D.T. for help, as the time factor is not so important when the latter insecticide is employed, and successful results are consequently more certain. This change of treatment was carried out without – and indeed against – the advice of scientific advisors who continued to advocate the use of Derris instead of D.D.T. because of the danger of serious outbreaks of Red Spider following the use of D.D.T. Such outbreaks had previously occurred in England. Fortune seems to have favoured the Scottish growers, however, for so far D.D.T. has been extensively used without serious consequences, and it must be confessed that it is extremely efficient in eradicating the Raspberry Beetle.

The other beetle which is of importance is *Otiorrhyncus singularis*, the Clay-coloured Weevil. This is a very common species and having many alternative host plants it is an ever present source of trouble. The larval stage is passed in the soil where it feeds on the roots of plants without causing any apparent damage. In mid spring, usually about the first week of May in

Scotland, the adults emerge from the soil where they have been lurking since metamorphising and attack the aerial parts of the plants. In the case of raspberries they chew the petioles, severing or partly severing them so that they bend and the leaves hang down in a very characteristic way. Laterals are likewise attacked and also, most important of all, the flowering laterals. By severing a flowering lateral a weevil can destroy at one meal, as it were, a large number of flower buds. As there is no hope of the plant compensating this loss in any way, a severe reduction in crop may occur. Young canes growing from the bases of the plants are also attacked and if not killed, are at least severely damaged.

The clay-coloured weevil is a nocturnal insect and not very easily found in the soil. Until recently it has been rather difficult to control, poison baits being mainly employed. D.D.T., however, seems to provide a solution to the weevil problem. Field trials carried out in Scotland have shown that D.D.T. dust (10%) applied at the rate of 70 lbs. per acre to the soil along the drills and to the bottom 9 inches of canes gives a highly significant reduction in the extent of damage done. A 0.4% wet spray of D.D.T. made from 20% wettable powder and applied at the rate of 350 gallons per acre also gave good results. The insecticide is applied at the time when the attacks are expected to begin. No phytotoxic effects were discerned and no adverse effects on the important members of the predatory insect fauna were apparent.

The raspberry moth *Lampronia rubiella* is a species which, although always present, appears from time to time in huge numbers. In peak years over 90% of the buds on most canes are attacked.

Briefly the life-cycle is as follows. About the end of March or the first half of April, according to climatic conditions, the tiny red larvae emerge from their hibernacula in the soil and climb the canes. Each selects a bud into which it bores and there feeds for about three weeks. Pupation follows and the adult moths are active during June. The females lay eggs in the raspberry flowers and from these the first instar larvae hatch. These feed on the developing fruits but cause no damage. By late July – early August they leave the fruits and migrate to the soil where they remain until the following spring.

The losses suffered by growers from the attacks of *Lampronia* are considerable. When the initial buds have been killed by the larvae the plants usually attempt to recover to some extent by replacing the damaged buds by the growth of secondary buds. In this way it might be expected that a good crop would be ensured, albeit somewhat late in maturing. Unfortunately however a sizeable proportion of the larval population infest more than one bud before they attain full growth and it frequently happens that the secondary laterals on which the growers' hopes for a crop depend are also killed. From such a second wave of attack there can be no recovery.

Pioneer work on controlling this species was carried out in Holland using tar distillate washes. Similar experiments were performed by Scandinavian workers and a few Scottish growers in the Clyde valley also reported some

success. In order to obtain fuller information about the efficacy of tar distillate wash and to note whether D.D.T. might also be useful, trials were carried out in the east of Scotland area. The results obtained showed that tar distillate applications were all significantly more successful than those of the D.D.T.

It would appear that although, D.D.T. can give an adequate control of this pest a dormant season tar distillate wash of 8% applied at approximately 150 - 200 gallons per acre is more satisfactory.

Lygus pabulinus, the green capsid bug, is capable of causing damage which may be regarded as being of somewhat minor importance but which considerably annoys the growers. The most noticeable type of damage is severe perforation of leaves caused by the piercing and sucking habits of the insects. In addition, branching of the canes due to *Lygus* attack not infrequently occurs in raspberries and it is this phenomenon which is regarded as most serious because abundant branching not only renders a plantation unsightly but also makes the tying in of canes a more difficult task.

Experiments in which *L. pabulinus* nymphs and adults were confined separately on raspberry plants proved conclusively that this species *is* capable of causing branching by killing the growing points of the plants.

Observations made in Scotland show that there the lifecycle of this insect deviates slightly from what has been observed in the south of England. In the latter region *L. pabulinus* is said to feed on the woody host plant (i.e. fruit bushes, etc.) during its early life only, migrating to herbaceous plants to complete its life-cycle and produce a summer generation, which returns to the fruit bushes, etc. in autumn to lay eggs.

In Scotland, however, the insect has been observed to pass its entire life-cycle on the raspberry plants and, in addition, the summer generation *also* occurs on the raspberries. Members of this generation then lay their autumn eggs on the canes. This does not mean that there are no spring and autumn migrations between fruit bushes and weeds but rather that, in addition to the accepted train of events, there exists, in Scotland at least, this other type of behaviour. The importance of this is that the damage caused to raspberries by the bug is continued throughout the summer instead of being confined to spring and autumn.

The two aphides *Amphorophora rubi* and *Doralis idaei*, although occurring universally on raspberries and often in large numbers, do little harm by their feeding activities. However when it was conclusively demonstrated that they were vectors of many of the raspberry viruses their importance as pests was greatly increased.

Both species are common although *A. rubi* is perhaps the more abundant and more generally distributed.

The fact that both aphides occur in abundance on wild Rubus idaeus while *A. rubi* is also very common on wild R. fruticosus renders control of these species on cultivated Rubus somewhat difficult. It may be desired to plant a new cane nursery with plants which are initially free from aphis

contamination. This can be achieved by dipping the young canes, during the dormant season, in a bath of 5% tar distillate. The plants are only immersed for a few seconds but care should be taken to ensure that the canes are thoroughly wet. It has been shown that the plants may be completely immersed – roots and all – without suffering any ill effects.

Having rather hurriedly touched on the insect pests which occur on raspberries in Scotland let me conclude by mentioning one species of great importance which does not occur there. It is the Cecidomyid midge *Thomasiniana theobaldi* Barnes. Fortunately conditions in Scotland for some unknown reason, possibly climatic, appear to be unfavourable to this insect because, although it must often have been imported from England in consignments of canes, infestations of it have never been found in Scotland. This also applies to the related midge *Lasioptera rubi* Heeg, the raspberry stem gall midge.

DISCUSSION

Mr. **van Dinther**: 1. The speaker did not mention *Eriophyes gracilis* Nal., a small gallmite, which also attacks raspberries. Does this mean that the mite is of minor importance?
2. Could not it be possible that *E. gracilis* will act as a virus transmitter?

Mr. **Hill**: *E. gracilis* is of minor importance in Scotland, and so far the possibility of its acting as a virus vector has not been fully investigated.

Mr. **Heinze**: Genügt 1 *Lygus pabulinus* zur Abtötung der Triebspitze oder sind zahlreiche Exemplare dazu erforderlich? Werden auch ältere, erwachsene Blätter schwer geschädigt?

Mr. **Hill**: Es wurden 5 und 8 Exemplare für die Versuche benutzt, sie töteten die Triebspitze ab. Die Blätter wurden nicht abgetötet, wohl aber fiel der geschädigte Gewebe aus.

Mr. **de Fluiter**: BÖRNER distinquishes 2 *Amphorophora* species, vz. *A. rubi* Kalt. from blackberries and *A. ideae* Börner from raspberries, but according to HILLE RIS LAMBERS the morphological differences mentioned by BÖRNER are not reliable. In Holland however the "race" of raspberries is pale yellow or pale green, the "race" of blackberries dark green and shiny. Do these forms (or species) also occur in England and did you make any transmission experiments?

Mr. **Hill**: So far such colour forms have not been distinguished in Scotland to my knowledge. In our transmission experiments only *A. rubi* from cultivated raspberries were employed.

LES PARASITES DE LYONETIA CLERCKELLA

par
Ch. FERRIERE
Genève, Suisse

A une époque où les traitements chimiques contre les insectes nuisibles se perfectionnent et s'intensifient et où les actions secondaires de ces traitements sont discutés, parcequ'encore mal connus, les études écologiques complètes des ennemis des cultures prennent une importance très grande. Ces études, encouragées autrefois par MARCHAL en France, SILVESTRI en Italie, KEMNER en Suède, d'autres encore, n'ont rien perdu de leur valeur bien que les recherches chimiques aient aujourd'hui pris le dessus. Comme le disait récemment Mr. VAN DEN BRUEL de Belgique dans une conférence à Rome: „Un énorme travail d'ordre biologique reste à accomplir en parallèle avec celui du chimiste", et plus loin „Les recherches écologiques et zoosociologiques ont à ce point de vue bien des progrès à nous faire accomplir: songeons au rôle parfois déterminant des parasites, lequel peut dépendre d'hôtes de relais vivant sur des végétaux fort différents de ceux dont la défense nous préoccupe, . . ." Les ennemis naturels des insectes nuisibles, parasites et prédateurs, le rôle qu'ils jouent ou pourraient jouer suivant les régions et les conditions climatiques, sont encore très mal connus en Europe, où les recherches se heurtent à des difficultés de coordination des études et de détermination des espèces obtenues. En particulier les Micro-Hyménoptères parasites, petits Ichneumonides. Braconides, Chalcidides, Proctotrupides, Cynipides, qui apparaissent parfois en nombre considérable et agissent comme régulateurs de la multiplication de beaucoup d'insectes sont trop souvent négligés ou complètement ignorés. Les traitements chimiques les détruisent sans doute souvent par milliers et leur connaissance permettrait d'augmenter l'efficacité des traitements en combinant la lutte chimique avec l'action naturelle des entomoparasites et, dans certains cas avec la lutte biologique active.

Notre petite note sur les parasites de *Lyonetia clerckella* est un exemple de l'ignorance dans laquelle nous sommes encore sur les parasites de beaucoup d'insectes. KEMNER a publié en 1926 une étude très détaillée sur la morphologie et la biologie de cette mineuse des feuilles de pommiers en Suède. Il en avait obtenu 6 espèces de parasites, des Chalcidiens, dont le plus important était l'*Eulophus longulus* Zett., appelé maintenant *Pnigalio longulus*, un Eulophide qui parasite aussi d'autres chenilles de Microlépidoptères dans diverses régions d'Europe; les 5 autres espèces étaient aussi des Eulophides, connus pour la plupart comme parasites de chenilles mineuses. KEMNER avait remarqué qu'un grand nombre de ces parasites hivernaient dans les feuilles mortes sous les arbres et de six grands paquets de feuilles pris en différents endroits de Suède, il avait obtenu à la

fin de l'hiver 1654 parasites, dont 91% étaient des *Eulophus longulus*, 6% des *Cirrospilus vittatus*, 2% des *Chrysocharis boops* et 1% des *Sympiesis sericeicornis*.

En Suisse, *Lyonetia clerckella* est largement répandu mais occasionne rarement des dégats importants. Nous avons profité d'une forte invasion sur des pommiers à Vex, dans le Valais, où toutes les feuilles étaient minées, pour refaire les observations de KEMNER. Mr. le Dr. CLAUSEN, entomologiste suisse, eu l'amabilité de me faire envoyer un paquet d'env. 50 dm ^{3} de feuilles, ramasées en février sous les arbres. Mis en boite d'élevage dans un laboratoire, les parasites commencèrent à en sortir dès la fin de février et continuèrent à apparaitre jusqu'après le milieu d'avril. De ce seul paquet, représentant seulement une petite partie des feuilles tombées, j'obtins ainsi un peu plus de 250 petits Hyménoptères, qui avaient hivernés soit à l'état adulte, soit à l'état de chrysalides.

Dans un biotope pareil peuvent vivre ou hiverner différents insectes, il faut donc éliminer, après détermination, les espèces que l'on sait être parasites d'autres insectes ou dont le parasitisme est douteux. C'est ainsi que parmi les especès obtenues se trouvaient des Braconides, *Opius pallidipes* Wesm. parasite de Diptères Agromyzides, et *Perilitus coccinellae* Schr. parasite de Coccinelles adultes, deux Encyrtides, dont l'un, *Cheiloneurus elegans* Dalm. a été observée en Europe comme parasite de Cochenilles et aux Etats-Unis parasitant les pupes de la mouche de Hesse, *Mayetiola destructor* (il faudrait savoir s'il s'agit de deux espèces confondues ou de deux races biologiques d'une même espèce); enfin sont sortis aussi de très petits Trichogrammides de 1/2 mm de long, qui étaient des femelles brachyptères du *Trichogramma evanescens* race *cacoeciae* Marchal, parasites des pontes de *Cacoecia rosana*. Après ces quelques éliminations il restait encore 244 individus dans 11 espèces qui peuvent être considérés comme parasites de *Lyonetia*. C'est donc un plus grand nombre d'espèces que KEMNER avait observé en Suède et remarquons que le *Pnigalio (Eulophus) longulus* Zett., qui représentait plus de 90% des parasites de Suède ne se trouvait pas en Suisse; par contre un *Pnigalio stramineipes* Ths. que KEMNER avait élevé en quelques exemplaires avant l'hiver est apparu en 4 exemplaires dans nos élevages. Des autres espèces obtenues par KEMNER *Cirrospilus pictus* Nees a aussi été trouvé par nous, *Cirrospilus vittatus* Walk. correspond peut-être a une espèce que nous avons obtenu en grand nombre et que nous ne croyons pas être le vrai *vittatus*, *Closterocerus trifasciatus* Westw. n'a pas été trouvé chez nous et *Chrysocharis boops* Ths. est remplacé dans nos élevages par deux autres espèces de *Chrysocharis*.

Les 11 espèces de Chalcodidae que nous avons obtenus et étudies sont, par ordre d'importance, les suivants:

1. *Cirrospilus* sp. (près *vittatus*)	16♀ 37♂	0,9-1,4 mm.	22 %
2. *Tetrastichus xanthops* Ratz.	22♀ 29♂	0,8-1,6 mm.	21 %
3. *Omphale* sp. (prob. nov.)	48♀♂	0,6-0,9 mm.	20 %
4. *Achrysocharis* sp. (prob. nov.)	9♀ 22♂	0,6-1,2 mm.	13 %

5. *Chrysocharis niveipes* Ths.	15♀	8♂	1,2-1,6 mm.	9 %
6. *Chrysocharis aeneiscapus* Ths.	7♀	13♂	1,2-1,7 mm.	8 %
7. *Trichomalus diachymatis* Ratz.	2♀	3♂	2,0-3,5 mm.	2 %
8. *Pnigalio stramineipes* Ths.	3♀	1♂	2,6-3,0 mm.	1½%
9. *Sympiesis sericeicornis* Nees	1♀	3♂	2,0-3,5 mm.	1½%
10. *Cirrospilus pictus* Nees	2♀	1♂	1,0-1,5 mm.	1 %
11. *Solenotus viridis* Först.		2♂	1,1-1,2 mm.	1 %

Il est inutile d'entrer ici dans des détails de systématique (qui feront l'objet d'une autre étude). Remarquons seulement que des quatre espèces les plus abondantes, qui représentent entr'elles le 76% des éclosions, trois ne peuvent être identifiées à aucune espèce connues et sont considérées comme nouvelles et le *Tetrastichus xanthops* Ratz., parasite de larves mineuses, a encore été rarement observé et jamais de *Lyonetia*. Les autres sont tous parasites de chenilles mineuses, mais, à part les trois derniers, sont encore très mal connus. De ces 11 espèces, 4 seulement sont mentionnés dans le Parasite Catalogue de THOMPSON, qui résume les recherches de ces 30 dernières années.

Une meilleur connaissance écologique et systématique de ces parasites pourraient être bien utile. KEMNER avait proposé, dans le cas particulier, de transporter pendant l'hiver des feuilles tombées d'un verger très attaqué à un verger moins envahi, où les parasites pourraient arrêter le multiplication de l'insecte nuisible. Il est à remarquer en effet que *Lyonetia clerckella* hiverne à l'état adulte sous les anfractuosités de l'écorce du tronc et n'est donc pas transportée avec les feuilles contenant ses parasites. Mais le principal est de savoir que les feuilles sous les arbres fruitiers peuvent renfermer dans certains cas de très nombreux insectes utiles et doivent être préservés autant que possible de la destruction et de l'action des insecticides pendant les traitements d'hiver. Souhaitons aussi, en conclusion, que des jeunes entomologistes soient encouragés en Europe à entreprendre l'étude systématique de ces Hyménoptères parasites difficiles mais importants à connaitre.

DISCUSSION

Mr. **Blunck**: Die von Herr Dr. FERRIÈRE erwähnte ungewöhnlich starke Gradation von *Lyonetia clerckella* ist nicht etwa auf die Schweiz beschränkt. Sie hat auch West-Deutschland und die östlichen Teile von Österreich und vielleicht noch ein weit grösseres Gebiet ergriffen. Der Befall ist so stark, dass er 1950 zu vorzeitigem Blattfall bei Kirschen und damit zu fühlbaren Schäden geführt hat. Es interessiert daher jetzt auch uns Pflanzenärzte. In Bonn bearbeiten wir das Problem unter einem besonderen Gesichtspunkt. Wir wollen feststellen, ob die Übervermehrung des Schädlings nur auf die Witterung, z.B. auf den warmen und trockenen Jahren 1947 und 1949 beruht

oder ob vielleicht auch der zunehmende Einsatz der hochwirksamen synthetischen Insekticide mitspricht. Es wäre denkbar, dass diese die Nützlinge, d.h. die Räuber und Parasiten von *L. clerckella* stärker dezimieren als diese selbst. Wir suchen also den % satz der Parasitierung in Gebieten mit und in solchen ohne Übervermehrung von *L. clerckella* festzustellen und sammeln daher von möglichst vielen Stellen befallene Blätter. Das geschieht am einfachsten durch Aufsammeln des abgefallenen Laubes von Äpfeln, Kirschen und andere Prunusarten, somit von Birken, die auch befallen werden, im Herbst. Dann werden die parasitierten von den nicht-parasitierten Kokons getrennt und ausgezählt. Die Parasiten werden aufgezogen. Auch in unserm Material handelt es sich dabei in erster Linie oder nur um Chalcididen. Wir bitten die Herren Kollegen uns durch Einsenden von Blattmaterial dabei zu unterstützen. Die Determinierung der Parasiten selbst können wir nicht vornehmen. Wir bleiben dabei ganz auf die Hilfe der wenigen Spezialisten angewiesen unter denen ja Dr. FERRIÈRE in aller ersten Reihe steht. Seinen Wunsch es möchten in Zukunft wieder mehr Kollegen sich dieser schönen Wissenschaft widmen, schliessen wir Pflanzenärzte uns wärmstens an. Wir würden hilflos, wenn die Systematiker aussterben sollten. Vor allem möchte ich aber – und dabei glaube ich in Ihrer aller Name zu sprechen – Dr. FERRIÈRE unser aller herzlichsten Dank sagen, dass er uns so selbstlos immer geholfen hat, und wir hoffen, dass er das auch weiterhin tun wird.

Mr. **Couturier** signale l'abondance de *L. clerckella* sur pommiers et sur cerisiers au cours des dernières années en Alsace.

Mr. **Lindner**: Massenvermehrung anderer Insekten wird zurückgeführt auf klimatische Faktoren. (*Lithocolletis platani* an den Platanen in Südwest-Deutschland 1950!) Auch das Auftreten anderer Insekten die früher bei uns nicht auftraten, dürfte in gleicher Weise erklärt werden können (*Bombylius pictus* in Württemberg 1949).

Mr. **Speyer**: *L. clerckella* war auch in 1924 in Mitteldeutschland so häufig, dass die Kirschbäume teilweise entblättert wurden. Kontaktgifte gab es damals noch nicht.

ÜBER DEN BIRNPRACHTKÄFER

von

O. JANCKE
Neustadt, Deutschland

Der Birnprachtkäfer (*Agrilus sinuatus* Oliv.) ist nach den Feststellungen der deutschen Pflanzenschutzämter vor allem im südwestdeutschen Raum weitverbreitet. Befallszentren finden sich vor allem im mittleren und oberen Rheintal, aber auch am Bodensee, im Bezirk Trier und am Niederrhein bei Wesel (Abb. 1). Es wurde schon früher mitgeteilt, dass man ihn in Europa ausserdem in Holland, Luxemburg und Frankreich in erheblichem Ausmass antraf oder noch antrifft.

Nach vom Verfasser durchgeführten Untersuchungen über die im vorigen und in diesem Jahrhundert bekanntgewordenen Schadperioden sind die klimatischen Verhältnisse des Monats Juni in den fraglichen Zeiträumen für die eingetretene Massenvermehrung des Birnprachtkäfers verantwortlich. Es ergab sich nämlich, dass immer dann Schäden durch den Käfer eintraten, wenn mehrere Jahre hintereinander die Junimonate bezüglich der Wärme über und hinsichtlich der Niederschläge unter dem langjährigen Mittel lagen. Die Junimonate sind deswegen für das Leben des Schädlings besonders ausschlaggebend, weil sich in ihnen das Schlüpfen der Käfer, ihr Flug und ihre Eiablage abspielen, die wiederum für ein so wärmebedürftiges Tier, wie den Birnprachtkäfer umso ungestörter verlaufen, je wärmer und trockener diese Monate sind.

Während des Massenauftretens des Käfers im Rheingau in den Jahren 1892-1896 waren beispielsweise nach den Aufzeichnungen der Frankfurter Wetterwarte die Junimonate in allen genannten Jahren überdurchschnittlich trocken und in 3 Fällen zugleich erheblich wärmer als sonst. In den 10 vorhergebenden Jahren traten zwar 3 mal ähnliche Verhältnisse ein; diese günstigen Junimonate lagen aber nie in aufeinanderfolgenden Jahren. Als zweites Beispiel sei das letzte Schadauftreten in der Pfalz in den Jahren 1945-1949 angeführt. Hier waren in 3 Jahren die Junimonate sehr warm und in 4 Fällen ausserdem abnormal trocken. Die davor verzeichnete Massenvermehrung fand 1919-1923 statt. In den dazwischenliegenden 20 Jahren von 1924 bis 1944 war der Juni in 10 Fällen überdurchschnittlich warm und nur in 5 Fällen anormal trocken.

Man kann deshalb annehmen, dass der Birnprachtkäfer, wie schon früher dargelegt, ein periodischer Schädling ist, der bei Eintreten kühlerer und feuchterer Sommerwitterung wieder zur Bedeutungslosigkeit herabsinkt.

Was Beobachtungen über die Lebensweise angeht, so wurde die Eiablage mehrfach im Laboratorium an Birn- und Weissdornzweigen erzielt. Die zunächst weissen bis leicht grünlichen Eier sind im Durchschnitt 1,13 mm lang und 0,93 mm breit. Sie verfärben sich zunächst olivbraun, um nach 4-6 Tagen

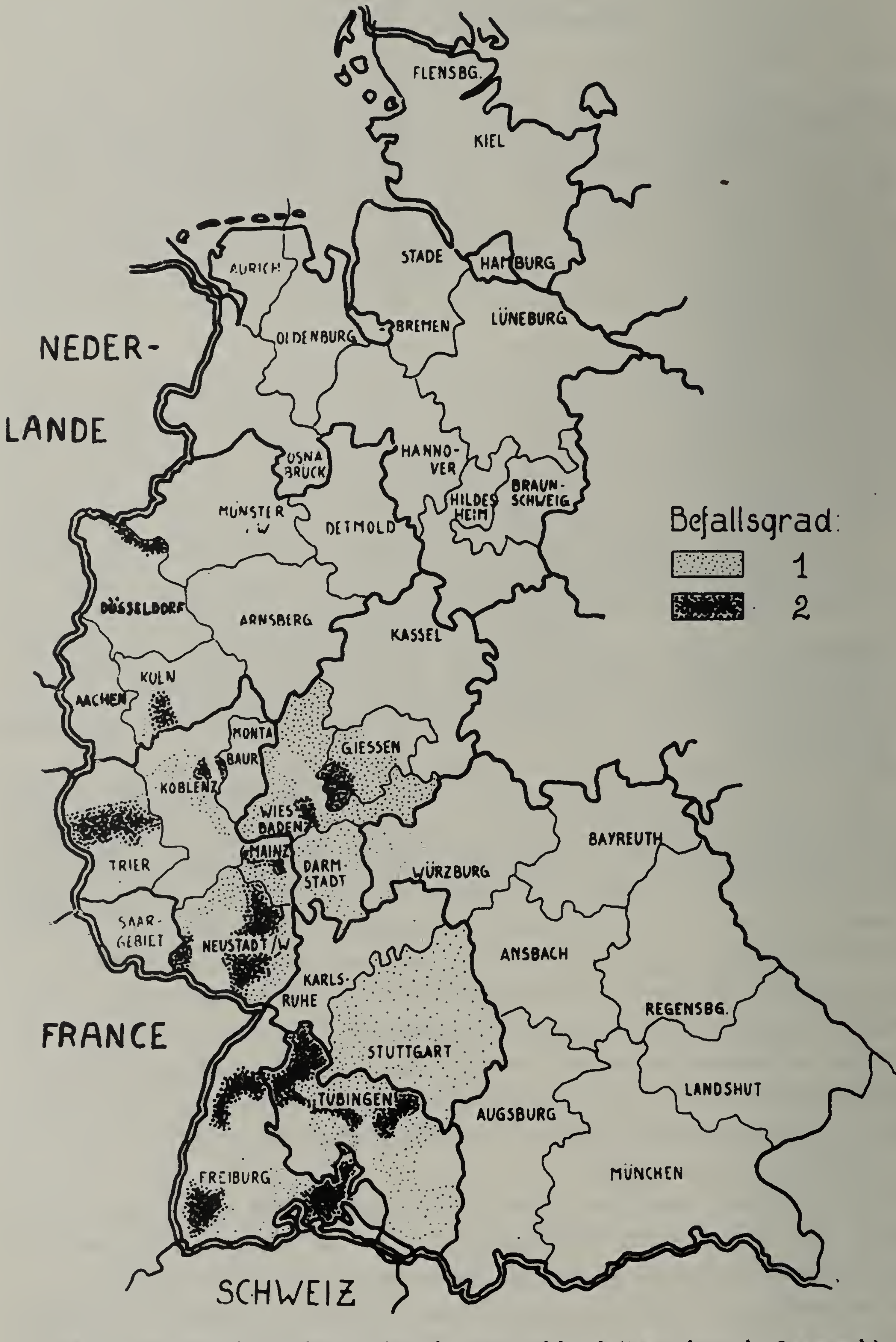

Abb. 1. Verbreitung des Käfers in Deutschland (1 = schwach, 2 = stark).

Abb. 2. Zuchtkäfige zur Beobachtung des Fluges der Käfer.

intensiv hellbraun auszusehen. Die Junglarven bohren sich durch die der Rinde anliegenden Eiseite unmittelbar in das Holz ein und entleeren ihren Kot entsprechend den Beobachtungen von GLASGOW zunächst in die leere Eihaut. Sie brauchen zu ihrer Embryonalentwicklung nach meinen Feststellungen bei 23° C 19-20 Tage. Ihre Gänge bohren sie im Splintholz stammauf- oder -abwärts.

Der Schlüpfverlauf des Käfers wurde zugleich zur Festsetzung des besten Bekämpfungstermins in grossen Freilandkäfigen verfolgt, die mit feinmaschiger Gaze (Fliegendraht) bespannt und Anfang bis Mitte Mai mit befallenem Baummaterial beschickt wurden. Im Jahre 1949 lief das Schlüpfen in etwa 3 Wochen ziemlich geschlossen mit zwei Höhepunkten ab, während im Jahre 1951 der Flug wohl infolge der wechselhaften kühlen Witterung in der Pfalz stark verzettelt war und sich mit Nachzüglern über den Juli bis zum 12. August hinzögerte.

Die Lebensdauer der Käfer erstreckte sich 1949 im Höchstfall auf 26 Tage für die Männchen und 21 Tage für die Weibchen. Im klimatisch ungünstigen Jahr 1951 lebten die Weibchen jedoch im besten Fall 13, die Männchen sogar nur 7 Tage.

Während nach unseren Beobachtungen in der Pfalz und FERRANT's Mitteilungen aus Luxemburg Mostbirnensorten widerstandsfähiger sind als Edel-

sorten, hält WARMBRUNN *) nach Untersuchungen in Württemberg erstere für anfälliger. Er stellte weiter fest, dass Birnen auf schweren, kalten und auf flachgründigen oder feuchten, aber hungernden Böden stärker leiden als sonst. Diese letzteren Ergebnisse, die sich zum Teil mit FERRANT's Angaben decken, können die Vermutung aufkommen lassen, dass der Birnprachtkäfer in gewissem Masse auch als Schwächeparasit anzusprechen ist.

Die Bekämpfung wird in Amerika mit hochprozentigen Arsenbrühen durchgeführt. Da ihre Anwendung sich bei uns verbietet, wurden Versuche mit E 605 0,05%, Gesapon (DDT) 0,5% und Nexen (HCCH) 0,3% angestellt. Sie ergaben, dass die Käfer auf alle drei Mittel gut reagieren und zwar am schnellsten auf E und HCCH. Freilandversuche in grossen Birnpflanzungen, die mit Kombinationen von E und DDT zur Ausführung kamen, bestätigten die Beobachtungen in vollem Masse. Die Spritzungen wurden im Zeitraum von 8 Tagen nach dem Erscheinen der ersten Käfer in den Freilandkäfigen angewandt. Fur stark befallene Anlagen wurde eine Wiederholung der Behandlung im Abstand von 8- 10 Tagen angeraten. Es gelang in mehreren Fällen, mit Hilfe dieser Massnahmen stark gefährdete Birnpflanzungen zu retten.

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DISCUSSION

Mr. **Nijveldt**: 1. Gibt's immer ein 2-jähriger Zyklus? 2. Wieviel Tage nach dem Ausschlüpfen der erste Käfer soll man die Bekämpfung ausführen? 3. Hat man auch Parasite gezüchtet? 4. Wird die eine Varietät schwerer befallen als die Andere? 5. Ist der Schaden primär? 6. Hat der Käfer sich verbreitet von schlecht unterhaltene Gärten zu die gut Unterhaltene oder ist der Schaden in beide Gärten gleich aufgetreten?

Mr. **Jancke**: 1. Aus Deutschland ist bisher nur ein 2-jähriger Zyklus bekannt. 2. 8- 10 Tage nach dem Schlüpfen der ersten ♀♀. 3. Ich erhielt nur 1 Parasit, der mir leider entkam, sodass eine Bestimmung nicht möglich war. 4. Es gibt Unterschiede im Befall der einzelnen Birnsorten. 5. In der Hauptsache ist der Schaden primär. 6. Stark befallen waren im Allgemeinen einige Grosspflanzungen, die besonders gut gepflegt waren. In der weiteren Umgebung befanden sich allerdings Strassenpflanzungen, deren Pflege zu wünschen übrig liess.

*) Nach brieflicher Mitteilung.

LA CECIDOMYIE DES POIRETTES (CONTARINIA PYRIVORA RILEY) DANS SES RAPPORTS PHENOLOGIQUES AVEC LE POIRIER

par
Remi COUTIN
Versailles, France

Il existe une concordance annuelle plus ou moins stricte entre le vol printanier de *Contarinia pyrivora* et le développement des organes floraux du Poirier. Ces phénomènes sont d'autant plus intéressants que la ponte ne peut avoir lieu qu'à l'intérieur de boutons floraux parvenus à des stades végétatifs bien définis.

1. Rapports phénologiques entre le vol et le développement des bourgeons floraux.

Pour connaître avec précision, afin de les comparer, l'époque d'activité des insectes et l'état de réceptivité des boutons floraux de chaque variété, deux techniques ont été employées: la cage piège placée sur un enfouissement préalable et la méthode de notation phénologique de J.FLECKINGER tirée de ses travaux sur la phénologie des organes floraux des arbres fruitiers (Fig. 1).

Dans les cages pièges, dix pour cent des insectes sont en général apparus le troisième ou quatrième jour après le début de la sortie. Ce délai et cette proportion d'individus correspond au seuil d'observation dans le verger, c'est-à-dire au moment où une personne non avertie aperçoit les premiers vols. A partir de ce seuil, la sortie s'accélère très rapidement jusqu'au maximum qui correspond, à un ou deux jours près, à l'époque où 50% des corymbes de la variété Passe-Crassane se trouvent au stade repère „E" de FLECKINGER (fig.2). Les services chargés des avertissements agricoles utilisent très couramment toutes ces indications.

2. Détermination expérimentale des stades de développement des boutons floraux favorables à la ponte.

a) Au verger, les fleurs sont infestées dès qu'elles sont réceptives, dans une proportion d'autant plus importante que le nombre d'insectes présents est élevé. Inversement, en dehors de cette période de réceptivité, le nombre de fleurs infestées est faible, bien que les insectes soient présents. C'est pourquoi les variétés de Poirier à développement plus précoce ou plus tardir que „Passe Crassane" souffrent beaucoup moins des attaques de *Contarinia pyrivora.*

Protection des fleurs. – Cette expérience porte sur les trois variétés: Passe Crassana; Doyenné d'hiver et Bon-Chrétien-Williams. Elle consiste à protéger de l'infestation des corymbes à des stades repères de développement

bien définis (méthode de notation de FLECKINGER) (Fig. 1). Les corymbes qui ne subissent aucune protection servent de témoins. De plus, des observations sont faites sur une variété précoce (Doyenné d'Alençon) et une variété tardive (D. du Comice).

L'infestation est calculée par rapport au nombre de fleurs infestées, car elles ne subissent par la suite aucune chute physiologique. Les résultats indiquent que (Fig. 3):

1 – A une date donnée et pour un même type d'essais, les corymbes sont d'autant plus infestés qu'ils se trouvent à un stade de développement voisin du stade „E".

2 – Des corymbes à un même stade sont d'autant plus infestés qu'ils n'ont pas été protégés à une date voisine de celle du maximum de la sortie de l'insecte.

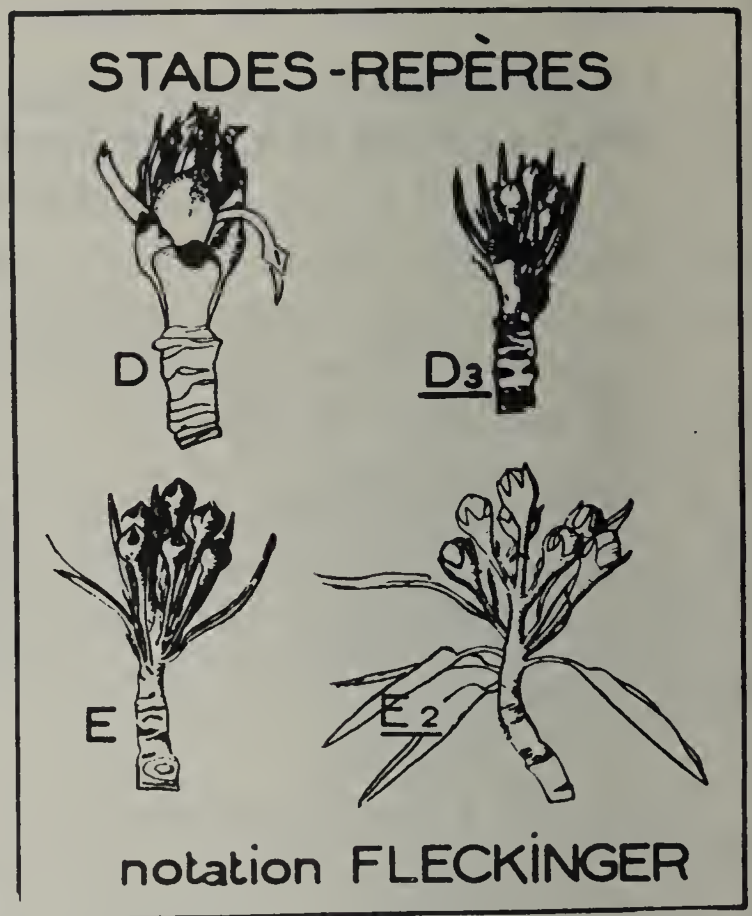

Fig. 1 – Stades repères de la notation phénologique de J.FLECKINGER

Ce résultat confirme le bref délai qui s'écoule normalement entre la sortie des insectes et la ponte.

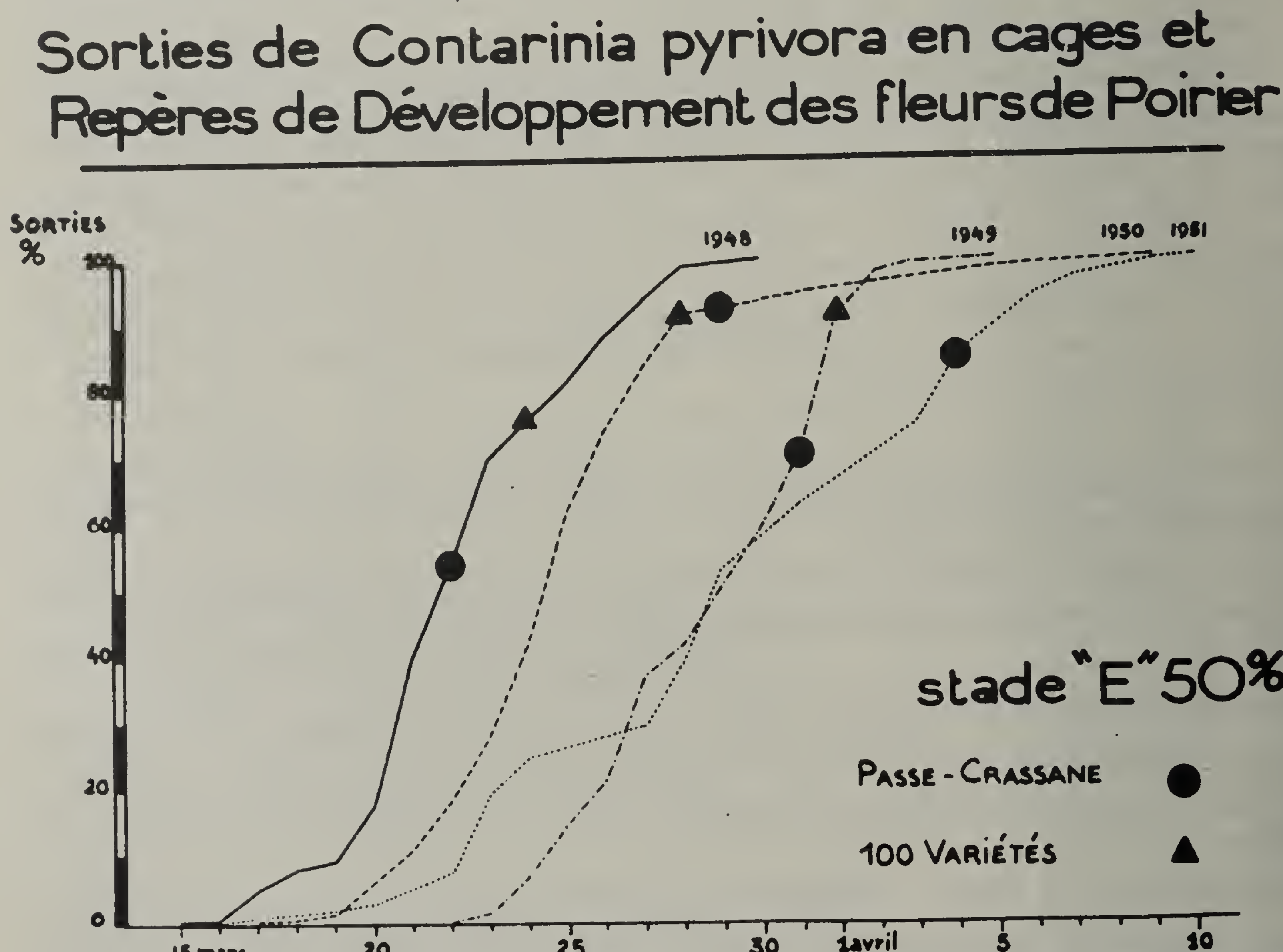

Fig. 2 – Sorties de *Contarinia pyrivora* et repères de développement. Le stade „E" 50% correspond à l'époque où la moitié des bourgeons à fleurs des arbres ont atteint ce stade

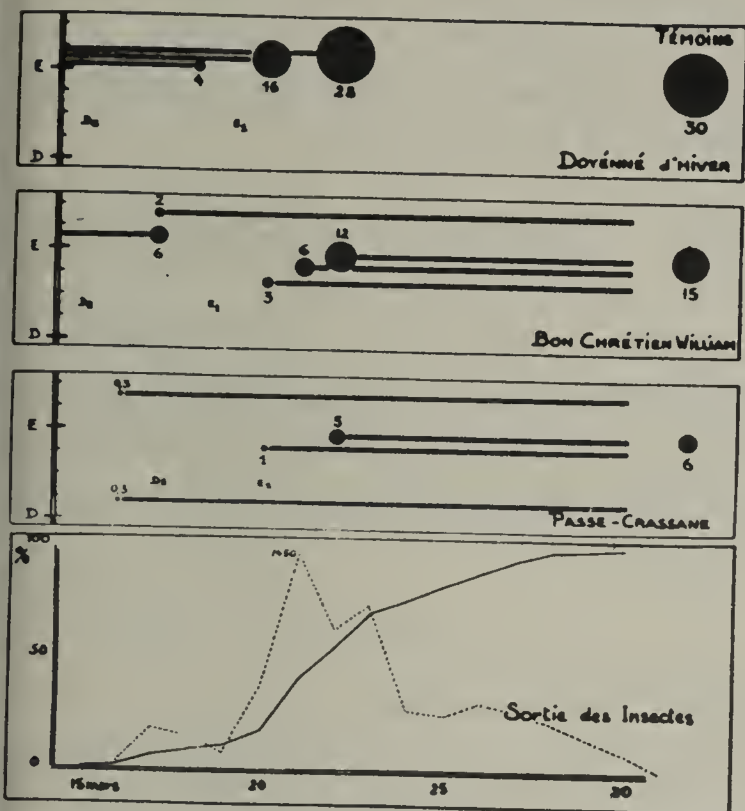

Fig. 3 — Infestation au verger de 3 variétés de Poirier. La sortie des insectes est figurée par une courbe des quantités journalières receuillies et une courbe cumulée en pour 100. Les cercles noirs expriment le pourcentage d'infestation des fleurs pour chaque variété. Les coördonnées de ces cercles indiquent la date et le stade phénologique à laquelle l'expérience a été effectuée.

Le trait noir, qui précède ou qui suit les cercles, représente la durée de protection des bourgeons

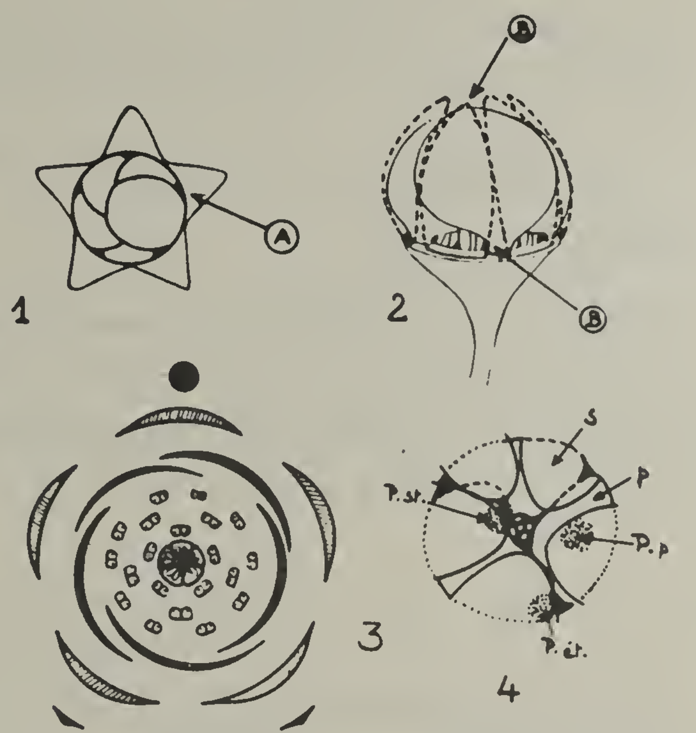

Fig. 4 — Représentation sémi-schématique de la morphologie des fleurs de Poirier. 1. Fleur à sépales rabattus montrant (A) les espaces libres entre les pétales. 2. Fleur dont les sépales enlevés permettent de voir les étamines. En (B) les deux points par lesquels les femelles introduisent leur oviscapte. 3. Diagramme de préfloraison. 4. Fleur de „Doyenné d'hiver" vue de dessus. s: sépale, p: pétale, pétales et sépales ne se recouvrent pas P: principaux emplacements de ponte Pp: sous les pétales, P.ét: sur les étaminés, P.st: sur les styles.

3 — Les différences d'infestation entre les trois variétés étudiées tient au fait que les différentes fleurs qui composent un corymbe se trouvent à des stades de développement plus ou moins différents. Si toutes les fleurs prises individuellement sont à des stades très voisins, l'infestation de chaque corymbe est plus importante. C'est pourquoi, dans ces essais, Doyenné d'hiver est plus infestée que Passe Crassane, et que B.C.Williams.

b) Au laboratoire, l'infestation des variétés Passe Crassane, Doyenné d'hiver, Doyenné d'Alençon et Beurré Hardy par un nombre connu de couples de Cécidomyies est étudié de la même façon en fonction des stades de développement. Des compétitions entre variétés au même stade réceptif sont effectuées.

Les corymbes choisis sont laissés en présence des Insectes pendant 24 h. dans un cylindre de matière plastique, renversé sur un pot rempli de sable humide, et recouvert d'une gaze. Les résultats obtenus confirment et précisent ceux précédemment cités.

De plus, la compétition entre variétés à un même stade montre bien qu'il existe de légères différences de sensibilité variétale, dues à l'état de déve-

loppement de chaque fleur prise individuellement dans chaque inflorescence et à des caractères variétaux de morphologie florale. Par exemple, le recouvrement des pétales est très faible chez Doyenné d'hiver; la pilosité des sépales est plus accusée chez Beurré Hardy (Fig. 4), etc......

3. *Influence de la morphologie florale. – Expériences de ponte sur fleurs mutilées.*

Par la mutilation des fleurs, les obstacles mécaniques qui s'opposent à la ponte sont écartés. En ôtant les sépales des fleurs d'un corymbe,,en pratiquant des trous au sommet des pétales, on facilite la ponte de *Contarinia pyrivora,* et les femelles déposent leurs oeufs dans des fleurs qui n'auraient pu être infestées sans ces artifices (Tab. 1).

Infestation de Bourgeons floraux mutilés

TABLEAU I	TEMOINS		ESSAIS				
Moyenne des nombres de fleurs infestées sur 10, pour 4 essais	Poirier avec sépales		Poirier en D_3			Poirier en D_1	Pommier en D_3
	Variété en D_3	Variété en D_1	Sans bractées	Sans sépales	Trous dans les pétales	Sans bractées	Sans sépales
	8.4	1.5	9.45	8.9	9.3	1.0	0.0
Ecarts à la moyenne	(7.5–10	(1.0–2.2	8.9–10	8.3–10	8.3–10		

4. *Attractivité des fleurs de Poirier sur les femelles de Contarinia pyrivora.*

Une expérience très simple permet de mettre en évidence l'attractivité des fleurs de Poirier sur *Contarinia pyrivora.*

Des couples de Cécidomyies sont maintenus 24 h. dans des cages en matière plastique posées sur sable humide. Si l'on introduit des corymbes de poirier à un stade réceptif après ce délai, les femelles se dirigent rapidement vers les fleurs et se mettent à pondre. Par contre, si l'on introduit des corymbes d'une variété de pommier à un même stade, les insectes restent indifférents. Cette attractivité des fleurs de poirier est vérifiée au moyen d'extraits, à l'éther, de ces organes.

Par badigeonnage de fleurs de poirier et de pommier avec le résidu d'évaporation, des pontes sont obtenues sur pommier, c'est-à-dire sur un support considéré comme indifférent (Tab. 2).

Attractivité sur Contarinia pyrivora d'extraits de fleurs de Poirier

TABLEAU 2	TEMOINS		ESSAIS		
Moyenne des nombres de fleurs infestées sur 10, pour 3 essais	Poirier avec sépales	Pommier sans sépales	Pommier sans sépales + extrait poirier	Pommier avec sépales + extrait poirier	Poirier avec sépales + extrait poirier
	7.6	0.0	2.5	0.0	6.9
Ecarts à la moyenne	(5.3–10)		(1.8–2.8)		

5. *Conséquences économiques de ces rapports Insecte-Plante hôte.*

Dans un verger de poiriers où plusieurs variétés coexistent, certaines d'entre elles sont peu attaquées par la Cécidomyie des poirettes, alors que d'autres le sont beaucoup plus. Il est intéressant de comparer, pour quelques variétés, l'importance de ces attaques avec leur précocité ou leur tardivité.

En classant un certain nombre de variétés très cultivées d'après leur époque de développement, par l'analyse phénologique de FLECKINGER il est possible de superposer à ce classement une échelle de sensibilité aux attaques de *C.pyrivora.*

6. *Conclusions*

La Cécidomyie des Poirettes est une espèce dont la phase printanière de développement et le comportement de ponte sont en rapport étroit avec la Plante-hôte.

L'infestation est importante sur les corymbes aux stades D_3, D_4, et E_I, et dans la nature, un corymbe passe par ces différentes phases réceptives en huit jours.

Expérimentalement toutes les variétés de Poirier permettent à l'insecte d'assurer sa multiplication; mais dans les conditions naturelles ce rôle est seul assuré par certaines variétés et les précisions que l'on peut obtenir en matière d'avertissements agricoles sont basées entièrement sur ces concordances phénologiques.

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DISCUSSION

Mr. **Barnes**: How did you determine that 80% of *C. pyrivora* emerged after one winter and 20% after the second winter. Did not you determine any emergency after any further delay?

Mr. **Coutin**: Des cages sont placées chaque année sur les enfouissements des années précédentes. L'on voit aussi que le phénomène de diapause prolongée se produit sur deux hivers et que 20% des insectes environ ne sortent que deux printemps après. Aucune sortie n'a été observée une troisième année.

THE THRESHOLD OF REPRODUCTION IN INSECTS AND ITS APPLICATION TO AGRICULTURE

by

E. RIVNAY

Rehovoth, Israel

It is not intended to present in these paragraphs facts new to science. The subjects discussed here, were published by the writer on previous occasions. The aim of the present paper is to point out the application to agriculture of some important data in insect ecology. Special reference will be made thereby to some entomological aspects in Israel.

Much has been written about the threshold of development in insects, that degree of temperature at which the development of the insect comes at an apparent standstill. The formula, that well known Blunk Formula, by means of which it is possible to calculate this degree from two given data of temperature and their respective development periods, has also been the subject of many discussions and even controversies. It was pointed out time and again how applicable it may be in calculating the number of generations of a certain insect as well as other data.

However, in my experience, it proved to be more valuable to calculate the development for each phase separately; the rate of development of an insect may vary in each phase. Thus, the development of the embryo in the egg may go on at a low temperature at which the larva would not develop. And the larva of the insect will develop at a temperature at which the adults will not reproduce.

The temperature where the biological functions which have to do with reproduction, namely courting, mating and oviposition, come to a standstill, is called the threshold of reproduction.

Before touching the main subject, a few words regarding the method of calculating the threshold of reproduction.

First efforts were made by attempting to calculate the number of eggs laid by an insect at given temperatures during a definite length of time. But the rate of egglaying in insects is so variable. One insect may lay most of its eggs in one or two days. Another a large batch in one day, stop for a few days, then another large batch will be laid. Furthermore, egglaying is the subject to so many other factors. My efforts in this direction were futile.

Attempts were made also to calculate the length of the preoviposition period at various degrees of temperature and apply to it the Blunk formula, and thus obtain the threshold of reproduction.

Difficulties were encountered in this direction too. The preoviposition period may be too short. Some hymenoptera may lay even in the same hour of their emergence from the cocoon. On the other hand this period may be too long. In the case of *Capnodis,* for instance, the shortest preoviposition per-

iod recorded was about six weeks; at colder temperatures it may be prolonged into a hibernation period, a fact which upsets all calculations. In the case with the Mediterranean fruit fly the situation is better, and with many and careful data it could perhaps be worked out. However in my studies I was not successful. One of the reasons is that, in my opinion, the degree of temp. 26-27°C is the optimum temperature for oviposition; at a higher temperature than this, the fly becomes more sluggish, thus one may obtain approximately the same records for temperatures of 25° and 29° C.

Thus the only way left for us is the simple breedings with the purpose of obtaining empiric data. This seems to be a tedious work, but with insects of economic importance, once obtained it is worthwhile, as illustrated in the three following examples.

(1) *Clausenia purpurea* Ishii is an Encyrtid parasite introduced from Japan into Palestine in 1940, to control a mealy bug of the *Ps. comstocki* group. This pest was first discovered in Palestine in 1937 on Citrus trees; but during three years it spread and developed to such an extent that every effort leading to its control was justifiable. The biology of *Clausenia* was studied and after all hyperparasites which were introduced with this species were eliminated, *Clausenia* specimen were liberated in the groves. Routine breedings of the parasite were also undertaken by the government and are continued to this day. Whenever a new focus of infestation is discovered, specimen are liberated there and a short period after this the pest is checked. In connection with this it was important to know how late in the fall and how early in the spring the insect should be liberated.

Breedings in the lab. at various degrees of temperature showed that the insect continues to oviposit even at a temperature of 15° C, while at 13-14° C egglaying ceases or becomes very rare. The threshold of reproduction was found therefore to be about 4 degrees higher than the threshold of development which is in the neighbourhood of 10-11° C. If we bear in mind the climatic data of Israel, it is evident that this encyrtid may continue to oviposit as late as November and as early as March. In fact the writer observed it ovipositing in the grove in a warm February day.

(2) *Capnodis carbonaria & tenebrionis*, the notorious almond root borers are Buprestids, native to the Mediterranion region. Until a few years ago, before adequate control measures were found against them, they were considered the primary limiting factor to stone fruit growing in Israel. The biology and control measures of these species were studied by few entomologists in Israel.

The eggs are laid in the ground in the neighbourhood and around the root crown, and the hatching larvae penetrate into the ground and the roots. The larvae in the roots may be controled by the fumes of Ethylene dibromide. Also prophylactic measures may be applied against the neonate larvae by dusting around the trees with BHC or DDT, and cover the dust with earth. However, the easiest way under Israelian conditions where labor is high, is the spraying of the trees with a suspension of a stomach poison or a good

synthetic insecticide with the aim to kill the adults before they begin to lay eggs. The time of this application is of primary importance, and in adjusting it the knowledge of the threshold of reproduction is essential.

The adults of *Capnodis* may be found almost all the year around. They begin to emerge in large numbers in April. As soon as they appear, the farmers are inclined to apply the measures of control.

However studies of the pests showed that while the larvae may continue to develop even to the temperature of 18-19° C, adults do not lay at a temperature below 25-26° C. In other words the threshold of reproduction is about 7-8° C higher than the threshold of development. If we study climatic data in Israel we see that the pest begins to oviposit early in May, rarely late in April. The first spray in the season is aimed at killing the overwin-:ered adults, and it is most advisable to do it after all the adults have emerg-ed, because the spray on the three is no longer effective after 8-10 days; :he latest possible data therefore in early May. The second spraying is aim-ed at the newly emerging beetles. These begin to emerge early June. How-ever they do not begin to lay until about six weeks after their emergence. So the second spraying may be postponed to the middle of July. This spray :ontinues to be active until the end of July. Very few adults emerge after his date and if they do seldom lay in the same summer. By postponing the irst spraying to early May, it was possible to do away with one spraying which was practice before. This was made possible by the exact information vailable regarding the threshold of reproduction and preoviposition period.

(3) *Ceratitis capitata* Wild, the Mediterranean fruit fly is the limiting actor of growing apricots and peaches in the coastal plain in Israel. The ly is inactive during the main citrus season, but manages to cause heavy osses to the citrus farmer during the autumn and spring when the tem-erature is more favorable to the fly. The losses for 1951 were estimated) over one million pound sterling. In order to make clear the point dis-ussed below, it should be pointed out that while the fruit which is stung in ie spring becomes wormy, that fruit which is stung during the autumn as a ile does not develop worms. The oviposition hole is distinctly noticeable, ie appearance of the fruit may be marred, but the fruit in itself remains in-ct. This is due to the fact that the oil or gum exudate in the peel kill ery larva before it penetrates into the fruit. As the fruit becomes more ripe becomes more susceptible to worms. Thus by December 10% of the stung uit may be wormy, while by January and February 20-30% may be wormy. ie inspection authorities in Israel, allow the export of oranges in the tumn even if the fruit shows signs of attack by the flies. This practice is established recently after it has been proved again and over again that s fruit does not breed larvae.

However, in order to prevent the stipment of wormy fruit it was imperative know exactly how late every year the fly ceases its attack in the fall. us if its activity continues till December some of the fruit may become rmy. In this connection our knowledge of the threshold of reproduction of fly is of great importance.

The biology, ecology and control of the fly were, and still are, the subject of study of several students in Israel. While the threshold of development was found as well calculated to be in the neighbourhood of 10- 11° C, the threshold of reproduction was found to be as high as 15- 16° C. That is about 5° C higher. Studying the climate of the coastal plain in Israel, one should conclude that by the end of November the fly becomes inactive. As a rule this is the case, but occasionally as was the case in 1951, when the so called winter of Israel was still milder than the usual, the fly remained active throughout the citrus fruit season. Based upon our knowledge of the knowledge of the threshold of reproduction, inspection practices, picking of fruit and its packing and export were regulated accordingly. Continuous inspection in the grove, confirmed our conclusions which were based on the threshold of reproduction.

DISCUSSION

Mr. **Gasser**: La méthode de placer les traitements seulement au moment ou les adultes sont capable de pondre, semble être la meilleur pour *Ceratitis capitata*. Est-ce que cette méthode est practicable dans les cas ou les adultes font des dégâts eux-mêmes, comme par exemple *Capnodis tenebrionis*?

Mr. **Rivnay**: The damage of *Capnodis* by the adult beetle is very negligible; we are concerned primarily with the larvae in the roots.

Mr. **Maher Ali**: It was observed, that different kinds of citrus are attacked differently from each other. Does this mean that the fruits themselves have something to do with the suppression of oviposition by the flies?

Mr. **Rivnay**: I observed that too, but there are many fruits during the season which are subject of attack, and my studies are based upon observation on such fruit.

Mr. **Raw**; Is the threshold of reproduction related only to behaviour of insects in reproduction, or is it also related to the physiology of maturation of ovaries and testis?

Mr. **Rivnay**: I noticed that at temperatures below the threshold of reproduction, flies continued to make holes, but the holes were empty – suggesting that the activity associated with egg laying is not necessarily hindered at that particular temperature, but the actual laying of the eggs was hindered.

THE ASSESSMENT OF INSECT POPULATIONS IN RELATION TO CROP LOSSES

by

A.H.STRICKLAND
Harpenden, England

I have chosen the title "The Assessment of Insect Populations in Relation to Crop Losses" for this paper because it emphasises a point which, from the rather scanty literature on the subject, seems to have been alloted a relatively minor role in surveys of economic pests. I refer, of course, to the operative phrase: "The Assessment of Insect Populations".

My thesis is simply explained. Certain insects cause economic damage to plants. In general, as pointed out by Mr. SOLOMON in his Section 11 paper on 18.8.1951, the greater the number of insects, the greater the amount of damage caused. From the economic viewpoint the damage is all-important and a knowledge of its extent in any given case is necessary in order that expenditure on cultural, biological, and chemical control measures can be estimated and budgeted for by the farming community. However, the matter does not end there. The pest lies behind the damage and it is to the pest that we must look for a proper understanding of the problem. The really important matter seems to me to be not so much the estimation of damage pure and simple as the estimation of pest abundance in relation to damage caused. In other words we need, in most cases, an altogether more profound knowledge of the underlying factors if we are to be in a position to understand the mechanism of pest abundance and arrive at a sound basis for preventing damage. My thesis is, then : Damage Assessment work should be tackled from the vital, rather than the pathological, standpoint if the greatest returns for time and money spent are to be obtained.

. *Aims and Objects*

It seems appropriate, at this juncture, to examine the aims and objects of conomic insect phenology. There is unfortunately, very little literature on he subject of pest and damage assessment surveys (which contrasts markedly with the vast amount of literature pertaining to the small scale expemental determination of populations and damage in relation to control ethods). In fact, in the literature of the past ten years I have been able to nd only two papers which discuss the implications of large scale insect urveys. One of these summarises the position in the United States, and the ther refers to work in the United Kingdom.

PARKER (1942) in his paper "Annual Insect-Damage Appraisal" stresses e strictly economic need for securing greater returns on public funds insted in entomology, and points out that pest assessment is essential in termining the efficiency of control methods.

THOMAS (1948) goes into the subject in some detail and sets out the ultimate aims of the work of the Pest Assessment Committee of the United Kingdom Conference of Advisory Entomologists. These aims, defined in 1945, are: -

(1) To record the fluctuation from year to year in insect populations and in damage done to susceptible crops, and to see what correlation exists between them.

(2) To determine the extent to which overwintering egg populations of certain insects are related to subsequent infestations on summer hosts, and

(3) Eventually perhaps to be able to forecast outbreaks of attack by insect pests so that adequate precautions can be made to meet them.

In both papers great stress is laid upon the need for a new approach to damage assessment work, and PARKER suggests that a national system of recording pests and their damage should be instituted in America. In this respect he points out that a number of large scale surveys have in fact been in operation for a number of years – the annual boll weevil survey since 1909, and the grasshopper survey (the latter involving cooperative work on the part of 22 States) since 1931. PARKER continues:

"There is no intention to minimize the difficulties which would be encountered in organising and operating a national system of insect-damage appraisal...; lack of standardised methods and the obscure nature of the injuries caused by some insects greatly reduce the number of pests for which reliable data could be obtained immediately; determining the degree of insect injury when the host was also affected by drought or a plant disease and the assignment of losses to specific insects when several were present on the same host would be exceedingly difficult.... None of these obstacles are insurmountable, and with proper organisation and financial support all could be overcome".

THOMAS points out that results from the United Kingdom wartime wireworm survey, and detailed cooperative flea beetle work, led Advisory Entomologists to be dissatisfied with generalised estimates such as infestation "normal", "above normal", and "below normal". This dissatisfaction resulted in an attempt to put pest and damage assessment in the United Kingdom on a more satisfactory basis, with the aims I have given above stated as guiding principles.

2. *The Position in the United Kingdom*

The position in the United Kingdom in 1945 thus differed somewhat from the position in the U.S.A., where large scale surveys on a number of pests had been in operation for up to 40 years, and where the snags and pitfalls in such work were better known. In the United Kingdom, on the other hand, valuable experience had been gained during the six years spent on surveying wireworm populations during the war and it had been demonstrated that inter-provincial cooperation essential to the success of large scale survey work was an established fact. The ground had, in fact, been well prepared for the setting up of a country-wide scheme for the routine assessment of

incidence, and damage caused by the most serious economic pests occurring in the British Isles.

Work was accordingly put in hand, early in 1946, on some 15 pest species using methods which it was thought would be appropriate in each case. However, it was soon found that the sampling methods employed were, in a number of cases, inappropriate. The result was that at the end of 1950 only eight pests remained on the list, these for the most part being investigated in greater detail than in 1945.

In December 1950 the results of the previous five years' work were reviewed by the Pest Assessment Committee of the Conference of Advisory Entomologists. At this stage it was abundantly clear that the aims set down in 1945 were, in most cases, not being achieved. In particular, little, if any, relationship was apparent between overwintering aphid egg populations and subsequent summer host populations in spite of the fact that individual research workers were consistently obtaining results indicating that a good relationship did exist. In addition, with the exception of leatherjackets (larvae of *Tipula* spp), it had not been found possible accurately to forecast summer pest outbreaks on the basis of one or two winter or early spring samples.

Methods

It seems appropriate at this stage to discuss insect sampling methods n some detail as it is to inappropriate methods, rather than lack of accuracy r keenness on the part of the observers, that the United Kingdom scheme ad to be drastically revised at the end of 1950.

In the first place it is essential for any method to be based on a detailed nowledge of the biology of the pest to be investigated. It is of little use, or example to take a sample of the young leaves of a host plant if, in ractice, the pest occurs in greater numbers on the mature leaves, and it is bviously no use recommending an estimate of leaf blotches as a population ndex of a leaf miner unless the relationship between the numbers of blotches nd mining larvae has first been established accurately. And when a good ethod has been found it must be remembered that enormous heterogenieties re involved even when comparing the same pest on the same plant species rowing in areas one hundred or so miles apart, and that a method suited to ne area might not be adequate for the other area. However in general this ifficulty can be overcome by employing suitably intensive sampling methds.

In the second place it is essential that the samples be taken in a statiscally appropriate manner if valid field to field and season to season comarisons are to be made. In this respect selecting plants at random along the wo diagonals of a field is as good a way as any of obtaining the desired ample.

Thirdly, the reliability of the estimate must be determined. Confidence mits can be set to any desired degree of accuracy and sample size fixed ccordingly. In much insect population work however the limits of accuracy

seem to lie at about 20% with a probability of 1 in 10, greater accuracy usually entailing an impossibly large sample. It is clear that any feasible system of large scale field sampling is only likely to enable gross differences (for example, a doubling or trebling) in population density to be shown as statistically significant. For instance, some Cabbage aphid (*Brevicoryne brassicae* Linn:-) survey results which I was looking at recently indicated that a sample of 25 plants per five acre field would show up a seven-fold increase in aphid density as statistically significant. A sample of 50 plants would show up a doubling of aphid numbers as significant.

Fourthly, the dangers inherent in visual estimates – particularly where numerous individual observers are involved – must be emphasised. In the present state of our knowledge it is not known for certain (though it is thought to be the case) that Cabbage aphid populations are generally higher in the Eastern part of England than in the South Western part. If this really is the case it is obvious that an observer in the South West, who had had no experience of conditions in the East, might well classify a "moderate" infestation as a "severe" one, and conversely that a worker in the Eastern part of the country, on transfer to the South West, would tend to feel that Cabbage aphid populations were, in his experience, low and to classify what was really, for that area, a moderate infestation as a "slight" one. This is, perhaps, an oversimplification of the true state of affairs. However, whereas the terms "slight" and "moderate" may be defined with passable accuracy the term "severe" must, by definition, be made to include all populations above the "moderate" category and no satisfactory quantitative value can therefore be ascribed to it.

Lastly the problem of damage assessment. Ideally, crop losses should be expressed in terms of reduction in yield per unit area or per plant, ascribable to insect attack, a correction being made in cases in which physical insect damage renders a crop partly unsaleable at the prevailing market prices for human consumption, and sale has to be effected at stock feed prices. In general it would appear that damage assessment can be included quite simply in surveys of dipterous larvae such as the Carrot fly (*Psila rosae* Fab.). In many cases, however, separate surveys must be arranged.

4. *The Organisation of Large Scale Surveys*

I have said enough about basic principles and methods to be able to proceed to the difficult question of the organisation and implementation of large scale surveys. The factors of prime importance are: First, full cooperation on the part of individual recorders stationed throughout the area to be covered by the survey; secondly, an adequate assessment of the time and labour available for survey work, and thirdly, the nature of the survey to be conducted. To a large extent the third factor is conditioned by the second, since it is clearly unwise to make detailed specifications as to sampling on a scale that cannot be maintained with the resources available. And finally the need for a central depot to which survey information is sent, and which

is responsible for the collation of the field results must be stressed. In the U.S.A. this work devolves upon the Department of Agriculture Division of Insect Survey and Information, and in the United Kingdom on the Pest Assessment team at the Ministry of Agriculture's Plant Pathology Laboratory at Harpenden.

A survey being conducted largely by advisory entomologists must have a strong economic bias, and the results must be of general use to the officers concerned if their willing cooperation is to be obtained. In the case of the United Kingdom at least the keenness with which the advisory entomologists have embraced the scheme is a reflection of the value which they ascribe to the results. But, in the United Kingdom at least, advisory entomologists have a host of different duties to perform and the time they are able to devote to assessment work is strictly limited by these duties. Anything in the nature of full time work cannot, therefore be considered.

For agricultural advisory purposes England and Wales are divided into twelve provinces or sub-provinces, each very roughly 5,000 square miles in area, and each with its full time advisory staff of one advisory entomologist two, or three assistant advisers, and up to six trained technical assistants. In 1950, with eight pests being assessed on a routine basis each advisory centre devoted, very roughly 50 man-days per annum to this work. If we break this 50 man-day period down it becomes apparent that roughly 25 man-days were devoted to the three aphids *Myzus persicae* Sulz., *Brevicoryne brassicae* and *Aphis fabae Scop.*, and about 20 man-days were devoted to dipterous pests. So that, on the average, observations were made on about eight days per annum on each aphid, the work being carried out on five to ten fields scattered over an area of up to 5,000 square miles in each case.

The problem to be faced in December 1950 was, therefore, to reconcile the fact that insufficient observations were being made on too many pest species with the fact that only about 50 man-days per province could be spared for such work.

With a known limit to the amount of time which could be devoted to the work the problem resolved itself into a consideration of the essential, as distinct from the generally desirable, results it was hoped to obtain from the work. It was felt, first, that the number of observations, and the number of sites observed, would have to be increased considerably above the "five fields per province twice per annum" scale which had tended to be regarded as a routine maximum if results were to be obtained from which accurate conclusions could be drawn. As such, any increase in the number of observations to be made on a given pest would automatically reduce the number which could be made on another species.

The next question concerned the pests to be surveyed in greater detail. Of the eight species which had been surveyed on what I will refer to as a reconnaissance scale over the period 1945-50 it was agreed that at least one aphid should be investigated on account of the importance of this group

of insects as pests, and the paucity of information generally available on aphid ecology and bionomics. After careful consideration it was felt that the Cabbage aphid would be an appropriate insect for detailed study. This decision was made for a variety of reasons, the principal being that the reconnaissance survey results had shown consistent trends which called for further investigation; that the consistency of these results permitted the evolution of a statistically sound sampling scheme; and that the Cabbage aphid is, as far as is known, restricted to Brassica species as host plants and the sampling scheme need not be complicated by the addition of alternative winter host counts. Finally the Cabbage aphid is a taxonomically stable species, and confusion with other species in the field, leading to inaccurate counts, seemed unlikely.

The nature of the observations to be made on the Cabbage aphid was the subject of detailed discussion. The reconnaissance survey had, on the average, given results referable to eight fields per province twice per annum over five years, and from these data it was possible to specify that a minimum of 20 fields per province would have to be examined if sound conclusions were to be drawn from province to province comparisons of data on, for example, overwintering egg populations. But if the aims and objects of the scheme were to be achieved it was patent that observations of a fundamental nature would have to be made. The difficulty was to draw the line between basic ecological, and applied economic, research. It was obviously not practicable to make daily or bi-weekly observations of an intensive nature on a country-wide basis with the resources available, nor would it have been practicable, on a routine survey basis, to make detailed observations on, for example, population density in relation to host variety. On the other hand it was felt to be essential for observations to be made on predator and parasite incidence, and very desirable that meteorological data be available for at least some of the sample sites. It was further considered essential that observations be made – anyhow on certain sites – at a frequency greatly in excess of twice per annum. And, in addition, the problem of assessing the economic damage done by the aphid had to be considered.

The scheme eventually agreed on consists of three phases: -

1. *The Extensive Survey.* Observations are made on 25 Brussels Sprout plants per field at random along one diagonal on a minimum of 20 fields per province or sub-province in September and in January each year. The survey is designed to provide reliable information on province to province variations in population density. In practice the 20 fields tend to be situated within the main provincial brassica growing areas so in fact the results provide a broad comparison of conditions within and between the main brassica areas in the United Kingdom. In addition information is obtained on the relationship between summer peak populations of aphids and overwintering egg populations.

2. *The Intensive Survey.* Observations are made on 50 Brussels Sprout plants per field at random at a rate of 25 plants along each diagonal on four

fields per province or sub-province 16 times per annum. Counts are made at fortnightly intervals during the period June through September, and at monthly intervals during the rest of the year. At the end of the Sprout season counts are transferred to adjacent fields of Spring Cabbage or Sprout seed crops in order to assess the carry-over of aphids from one season to the next. Intensive fields are sited, wherever possible, close to synoptic weather stations and supplementary observations are made on parasite and predator activity.

3. *The Damage Assessment Plots.* Plots are in the form of two adjacent 2 by 2 Latin Squares (eight sub-plots), and are set up in each important brassica growing area. In order to eliminate one variable, uniform Cambridge No. 5 Brussels Sprout seed is used throughout. Aphids are controlled on four of the sub-plots with TEPP and, if necessary, owing to a heavy build up of populations, with gamma BHC, and are allowed to build up naturally on the other four. Aphid populations are assessed on all plots once a month, and comparative yields are taken at the end of the growing season.

In addition to this country-wide scheme (which, incidentally, entails roughly 48 man-days work in the surveys, and at least 30 man-days on the damage assessment plots per province), a research worker has been appointed to work full time on the parasite and predator aspects of the work, whilst fundamental work on the efficiency of various rapid sampling procedures is being undertaken by the Pest Assessment workers at the Plant Pathology Laboratory at Harpenden.

By concentrating thus on one insect pest it is felt that the greatly increased number, and intensity, of observations made will, in the course of a few years, enable important and fundamental conclusions to be drawn concerning the mechanism of abundance of an important pest aphid. Once this fundamental knowledge has been obtained it will be possible to reduce work on the Cabbage aphid to a simple routine procedure – as has, in fact, been the case with the wireworm survey project for several years past – and to concentrate our efforts on obtaining fundamental information on other important pest species.

Summary

The relationship between insect pest potential and damage caused to susceptible crops during the growing season is of fundamental economic importance and surveys of agricultural pests should be designed to investigate this relationship in detail.

Methods appropriate to such work are discussed and the organisation of pest and damage assessment surveys on a country-wide scale is illustrated with reference to the work of the Pest Assessment Committee of the Ministry of Agriculture's Conference of Advisory Entomologists.

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DISCUSSION

Mr. **Broadbent**: Damage by some insects, especially aphids, may not be confined to physical damage as a result of feeding, many aphids, such as *B. brassicae* are virus vectors. Is any attempt being made to assess virus damage as well as feeding damage?

Mr. **Strickland**: An attempt will be made if plant pathologists can define the damage caused quantitatively.

Mr. **Rivnay**: In Israel, climatic conditions are such that there are two peaks and two depressions in fluctuation of population. So methods applied in England will not hold there.

Mr. **Strickland**: Methods must be adapted to the insect and plant species under investigation. It is clear, for example, the method I used for assessing mealybug populations on cacac in West-Africa – felling entire trees and counting all the bugs on them – could not be applied to v aluable apple trees growing in a planned orchard in England. But if we consider, for instance, the citrus black aphid – *Toxoptera coffeae* – then a method of assessing populations based, say, on twig samples, and developed in South Africa, should be applicable – perhaps with minor modifications – wherever citrus is grown?

Mr. **Heeley**: Are the assessments of insect populations to be utilised in attempting to forecast future degrees of attack on crops of economic importance? Owing to the influence of parasites or predators – as for example, in Red Spider and Myzus – does the assessment in many cases bear a reliable relationship to eventual attack?

Mr. **Strickland**: Intensive observation filed are situated close to synoptic weather stations. In course of time we shall accumulate a lot of data on insect populations which can be analysed in relation to meteorological data. If it is at all possible to forecast aphid attack from weather records, we shall therefore be in a good position to do so. When drawing up the details of our cabbage aphid scheme, we realised that observations would have to be made on natural enemies, and their effect on population density assessed. A full time aphid parasitilogist had now been appointed to carry out this work.

Mr. **Kuenen**: Is it considered with sufficient attention, that the damage is not dependant upon population density only, but also on many other factors?

Mr. **Strickland**: By standardising experimental plots, variation is eliminated as much as possible.

THE EPIDEMIOLOGY OF APHID-BORNE VIRUS DISEASES

by

L. BROADBENT
Harpenden, England

The control of insect-borne viruses is not the same problem as controlling pests. I would like to outline some of the features influencing the epidemiology of virus diseases to illustrate the principles involved.

On the basis of their behaviour in their insect vectors, plant viruses divide into two major types. First, the non-persistent type, which the insect can acquire from a diseased plant in a few seconds and that can then immediately infect a healthy plant during a short feeding period. An infective insect can sometimes infect more than one healthy plant after one feed on the source of virus, providing it stays only a short time on each. The insect usually loses its infectivity during feeding periods of minutes, and when fasting, in less than a day.

Secondly, there is the type of virus that persists for long periods within the insect. Insects usually have to feed on infected plants for considerable periods to pick up viruses of this type. In addition, there is usually a period of hours or days after the virus has been acquired, before the insect can transmit it again; but once the insect is infective, it may remain so for the rest of its life.

At Rothamsted we have studied the spread in the field of two persistent viruses, leaf roll virus of potatoes and yellows virus of sugar beet; and of three non-persistent viruses, potato virus Y, beet mosaic virus and lettuce mosaic virus. We are now turning our attention to two more non-persistent viruses, cauliflower mosaic virus and cabbage black ring spot virus. Each of these causes a disease of great economic importance. They are all transmitted by aphids, usually by one or more of the species that breed on the crop, but the non-persistent viruses may be transmitted also by some non-colonizing aphids, as they fly from plant to plant seeking a suitable host.

It will be appreciated that not only must insect vectors be present, but they must move from plant to plant before they can transmit viruses. It is not always the predominant aphid on a crop that is the most important virus vector; thus *Myzus persicae* (Sulz.) is often greatly outnumbered by *Aphis fabae* Scop. on sugar beet and by *Aphis rhamni* Fonsc. on potatoes, but although each of the other aphids can transmit virus in the crop in question, *M. persicae* is the more important vector, for it is a more restless aphid than the others. In lettuce *Nasonovia ribis-nigri* (Mosley) usually outnumbers *M. persicae*, sometimes fouling the plants until they are unsaleable, but it is not a vector of lettuce mosaic virus which is spread mainly by the numerically insignificant *M. persicae*.

Movement being the *sine qua non* of virus transmission, it follows that alate aphids are likely to cause more infections per individual than apterae. The

spread of virus from crop to crop has long been attributed to winged aphids, but it is only recently that these have been shown to cause much of the local spread from plant to plant within a crop. Apterae sometimes move from plant to plant, especially when the plants are large and in contact, but apparently if they transmit virus, they do so mainly to plants already infected by alatae. This is the reason why counts of total populations of vector species on plants often are not closely correlated with the number of plants which become infected, even when the sources of virus are known and allowance is made for multiple infections. However, it has been possible to correlate virus transmission with the catches of winged aphids on traps, which opens up prospects of forecasting the extent of virus spread. A forecast is useful when dealing with such crops as the potato, where the results of infection are often not visible until the following year; also it can be used in potato seed production to determine the time of harvesting the tubers in order to confine virus infection within prescribed limits.

Traps of various types have been used – wind and mechanically operated nets, sticky surfaces, suction and water traps. The Rothamsted suction trap is undoubtedly the best for population studies *per se*, but the cylindrical sticky trap developed at Rothamsted has proved its worth as a simple instrument for studies of virus epidemiology.

In these studies account must be taken of the factors influencing the number and movement of both alate and apterous aphids; and when something of these factors is known, the macro- and micro-climates of the crops, and of the districts where they are grown, must be studied to determine to what extent they apply. Four important influences are recognized: 1) the state of the plants, both infected and healthy; 2) the distance between infected and healthy plants; 3) the weather, and 4) aphid enemies.

Fast-growing, well-manured crops often contract more virus than poorer crops, and young infected plants often prove better sources of virus than older mature plants. There are three points to be considered here, the palatability of the plant for the aphid, the concentration of the virus in the plant, and its availability to the aphid. Thus an aphid, following the same pattern of feeding and movement at different periods of a crop's growth, will not necessarily cause the same number of transmissions on each occasion.

The greater the distance between diseased and healthy plants, the less chance there is of transmissions taking place; with both types of virus, dispersion of the vectors will increase with distance from the source. With non-persistent viruses, aphids will lose their infectivity if they spend some hours in finding a healthy susceptible plant, or feed on many non-susceptible plants in between. Thus isolation, adequate to keep a crop healthy, varies with different viruses; the necessary distance can be shorter if crops, especially those suitable for the aphid, but not susceptible to the virus, intervene between the diseased and healthy crops, than if bare ground intervenes.

Aphids do not fly in darkness. In daylight the most important factor affect-

ing flight is temperature, which affects the degree and extent of movement both of alatae and apterae; temperature also greatly influences reproduction. A secondary factor is wind, for aphids cannot fly voluntarily except in almost still air, and will not take off in high winds. But air movement is much restricted by plant growth and aphids will leave a crop, if other factors are suitable, only to be swept away into the air, from which they are deposited by eddies, or descend when the wind drops. For this reason hilly, windswept regions are not always safe from virus-carrying aphids, which may be deposited on the hill-sides by eddies as the wind pass over. Compared with light, temperature and wind, humidity, air pressure and light rain are of little consequence, though heavy rain will prevent flight and may wash aphids from a plant.

When two viruses, one non-persistent and the other persistent, occur in the same plant, and are transmitted by the same aphid, the weather may determine which of the two will be spread at any particular time. Thus with the potato viruses transmitted by *M. persicae*, the non-persistent virus Y is transmitted during weather favouring flight, when the aphids can flit from plant to plant, never staying long enough to pick up or transmit leaf roll virus. The persistent viruses can more readily be transmitted at night, or in cold or windy weather, under conditions which inhibit flight. The age of aphids also may play a part, for young alatae are much more active than old ones. Apart from age, individual aphids vary much in their ability to transmit a virus, and it is likely that there are races of good and poor vectors within a species.

The numerous predators and parasites of aphids are important in limiting the development of aphid populations, but little is known of their influence on aphid movement. The relations existing between aphids and their enemies have, in most instances, not been closely studied, and are seldom mentioned as factors affecting virus spread. The further study of biological control of aphids would be of value; in the meantime the two other methods of control, agronomic and insecticidal, are the subjects of experiments all over the world.

Many insecticides introduced during recent years have proved their worth as aphicides, but they are not necessarily of value in preventing the spread of aphid-transmitted viruses. There are two aspects to this problem, the prevention of the introduction of virus into a crop from outside, and the prevention of further spread within the crop. In as much as aphicides prevent the development of large populations, they reduce spread within a crop, and further, prevent winged forms developing in that crop and carrying the disease elsewhere. If they are rapid killers, they will kill visiting aphids before they can move to another crop, but there is no insecticide on the market today that can kill rapidly enough to prevent incoming aphids transmitting non-persistent viruses, either brought in with them, or from plant to plant within the crop. Sometimes the insecticides irritate the aphids, and cause them to move more frequently than they would do otherwise, and a greater spread of virus results than if an insecticide had not been used.

On the other hand, it might be expected that the spread of those persistent viruses that are transmitted only after long feeds, would be prevented by efficient aphicides. Much experimental work remains to be done on this problem, but it is possible that the selective systemic insecticides, in particular, will play an important part in the reduction of such important persistent viruses as potato leaf roll. If the chemist could discover an aphid repellant that prevented the aphids inserting their stylets into the plant, what a future that would have in preventing virus spread!

In the meantime more attention should be paid to agronomic methods of control, such as the rotation and separation of crops, the removal of diseased plants, the planting of barrier crops to arrest the aphids and „soak up" the virus, etc. These methods vary with the crop, the virus and the vector, and necessitate adequate studies on the epidemiology of the various diseases.

DISCUSSION

Mr. **Kamal:** What effect has temperature and humidity on the epidemiology of the peach leaf-roll?

Mr. **Broadbent:** I am not conversant with peach leaf-roll virus, but aphids will not fly at low temperatures (below 12° C in the case of *M.persicae),* and activity increases with increasing temperature to about 27° C. Also at higher temperature aphids reproduce more rapidly; for example I have calculated that *M.persicae* will pass through 3 generations in southern England in the same time as 2 generations in Scotland, given average weather conditions in the two areas. Humidity does not affect flight, but aphids settle to feed more readily at high humidities than at low.

Mr. **Heinze:** Zur Erläuterung der Frage des Diskussionsredners möchte ich mitteilen, dass in Dahlem Untersuchungen angestellt wurden, wieviel Generationen von *M. persicae* während des Sommers (etwa 15.5–15.8) an Kartoffeln entstehen. Addiert man die Tagesmittel der Temperatur, so sind als Temperatursumme etwa 200° C erforderlich. Die Addition der Temperaturmittel für die Sommerzeit liess etwa 8–9 Generationen während des Sommers erwarten. Die Freiland-beobachtungen entsprachen diesen Berechnungen recht genau. Von den Feuchtigkeitsbedingungen haben nur schwere Regen oder Hagelwetter einen direkten Einfluss auf den Aphidenbefall. 1938 setzte ein schweres Hagelunwetter den Blattlausbefall auch zu einer für die Aphiden noch günstigen Zeit auf ½ oder ¼ herab.

Mr. **Broadbent:** I agree with this, and have had similar experiences in England.

Mr. **van Marle:** The speaker said, that there are insecticides which by irritating the aphids, further the spread of virus diseases. Could you give examples of insecticides that have this effect?

Mr. **Broadbent:** D.D.T. alone of the insecticides we have tested (parathion, Pestox III, Toxophene and Dieldrin), caused an increase in the spread of potato virus Y, compared with controls. We have also an example of increased spread of lettuce mosaic virus when part of a crop was treated with D.D.T.

BIOLOGIE, SCHAEDEN UND BEKAEMPFUNG VON GETREIDEWANZEN (EURYGASTER INTEGRICEPS PUT. UND AELIA ROSTRATA BOH.) IN DER TÜRKEI

von
BEKIR ALKAN
Ankara, Türkei

1. Kurze Einleitung

Die wirtschaftliche Bedeutung des türkischen Getreidebaues ist gross. Beispielsweise betrug im Jahre 1948 die Getreideanbauflaeche ca 8 Million. ha., das Total der Ernteprodukte ca 9 Milli. Tonnen. Der Geldwert dieser Produkte ist ca 2 Milliarden türkische Pfunde (Lira). D.h. 700 Millionen Dollar, oder 250 Millionen Sterling.

Der türkische Getreidebau wird alljaehrlich von einer grossen Zahl tierischer Schaedlinge heimgesucht. Eine besondere Rolle spielen dabei Feldmaeuse (insbesondere Microtus Arten), Wildschweine, Feldheuschrecken, Getreidelaufkaefer (*Zabrus* Arten , viele *Anisoplia* Arten).

In den Süd- und Südostanatolischen Gebieten sind Getreidewanzen oder Weizenwanzen wie *Eurygaster* und *Aelia* sehr verbreitet.

In der Türkei wurden bis jetzt 5 *Eurygaster* und 6 *Aelia* Arten determiniert.

Von diesen *Eurygaster*- und *Aelia* Arten sind: *Eurygaster integriceps* und *Aelia rostrata* sehr verbreitet. Die anderen Arten wurden selten angetroffen.

Die Geschichte von Getreidewanzen dürfte in der Türkei ebenso alt sein, wie die von Heuschrecken, Feldmaeusen und anderen Schaedlingen. Trotzdem kennen wir diese Getreidewanzen erst seit ungefaehr einem Vierteljahrhundert.

2. Biologie, Schaeden und Massenvermehrung (Alles ganz kurz gefasst).

Getreidewanzen überwintern in der Türkei auf den Bergen von mindestens 1500 Meter Höhe über dem Meeresspiegel. Dabei findet man sie immer in grossen Kolonien unter den Polsterpflanzen wie Astragalus ssp., Acantholimon ssp. und resp. etwa 10 verschiedenen Unkraut Arten. Die Arten von *Aelia* überwintern meistens unter abgefallenen Eichenblaettern in der Provinz Tunceli oder auch unter Polsterpflanzen wie *Eurygaster.* Als maximale Höhe für die *Eurygaster*-Überwinterung wurde auf einem Gipfel vom Hazarbaba Gebirge in der Provinz Elazig 2230 Meter festgestellt (am 23.IX.1941).

Der Rückflug von *Eurygaster* und *Aelia* von den Gebirgen nach den Getreidefeldern beginnt im Süden (Adana, Antep...) von Ende Maerz bis Mitte April je nach der Witterung etwas früher oder spaeter, aber in Elazig, Tunceli, Malatya.... und in anderen Provinzen von der ersten Aprilwoche bis Mitte Mai. Auf den Feldern machen diese Altwanzen waehrend 10–15 Tagen einen Reifungsfrass an den milchreifen Körnern der Gerste. Spaeter begatten sie sich. Die Weibchen legen die Eier meistens auf Getreideblaetter oder auf

andere Pflanzen, dann sterben sie. Die Inkubationszeit der Eier duaert 7–20 Tage. Die ausgeschlüpften Larven entwickeln sich zum Imago in 20–30 Tagen. Diese Erwachsenen Getreidewanzen fliegen zur Erntezeit nach den Gebirgen für die Überwinterung.

Die Biologie von *Aelia* ist der von *Eurygaster* sehr aehnlich. Getreidewanzen haben jaehrlich nur eine Generation.

Der Schaden von Getreidewanzen ist erheblich. Sie stechen und saugen zuerst an den jüngen Getreidehaerzblaettern, und den Halmen, spaeter an den Blüten, den Spelzen und den milchreifen Körnern. Die Beschaedigung an jungen Getreidehalmen und Blaettern ist gering. Dagegen ist der Schaden an den reifenden Körnern sehr betraechtlich. In manchen Jahren vernichten diese Insekten das ganze Getreide, die Kornernte faellt aus, nur das Stroh bleibt übrig. Die angestochenen Blüten werden steril, milchreife Körner verkümmern und verschrumpfen. Stichflecken sind an den Oberflaechen von Spelzen und Körnern als kleine Punkte sichtbar. Nach eigenen Versuchen von mir verlieren solche Körner rund 50% an Keim- und Treibkraft. Die Backfaehigkeit und das Körnergewicht sind betraechtlich herabgesetzt.

Die Schaeden der Larven sind wie die von Erwachsenen. Den grössten Schaden von Getreidewanzen habe ich bei Weizen festgestellt. Dann weniger bei Gerste und Roggen, dagegen keine Schaeden bei Hirsen und Mais.

Über die Beziehungen zwischen der Massenvermehrung von *Eurygaster* und *Aelia* und dem Klima findet man zahlreiche Angaben in der Literatur. Nach ZWÖLFER ist die optimale Klimabedingung für die Eier- und Larven- Entwicklung von *Eurygaster integriceps* in Cilicien ein Temperaturdurchschnitt von 20–22 C° und 10–20 mm Niederschlag im Monat Mai. Dieser Monat trifft in Cilicien mit der Entwicklungszeit der *Eurygaster* – Eier und -Larven zusammen, ist also eine kritische Periode für die Massenvermehrung von *Eurygaster integriceps*. Diese optimale Klimabedingung muss aber mindestens zwei Jahre nach einander gegeben sein. Da dies natürlich nicht immer und überall der Fall ist, schwankt die Dichte von *Eurygaster integriceps* sehr stark, und die Massenentwicklung ist immer auf ein bestimmtes Klimagebiet beschraenkt. Ausserdem müssen in der Naehe der Getreidefelder hohe Gebirge für die Überwinterung vorhanden sein.

3. *Natürliche Feinde und Parasiten:*

Natürliche Feinde von *Eurygaster* und *Aelia* spielen keine grosse Rolle bei der Bekaempfung. Diese Insekten werden in manchen Jahren von den Vogelarten Störche, Rosenstaren, Rebhühner u.a. gefressen. Von diesen haben nur Rosenstare grössere Bedeutung. Auf den Feldern mancher Gegende fliegen diese in grossen Schwaermen und vernichten saemtliche Getreidewanzen in kurzer Zeit.

Parasiten von *Eurygaster*, welche bis heute in der Türkei beobachtet worden sind, sind folgende:

Telenomus semistriatus Ness (Hym. Proctotropidae), diese ist ein Eiparasit von *Eurygaster* und von anderen Pentatomiden Arten. Das Weibchen legt

ihre Eier in die *Eurygaster* Eier. Die parasitierten Eier sind dunkelblau gefaerbt, die gesunden dagegen sind zuerst grün, spaeter durchsichtig. Sie vernichten in manchen Orten die gesammten *Eurygaster*-Eier. Von *Telenomus* parasitierte *Eurygaster* Eier wurden mehrmals in Diyarbakir, Antep, Elazig, Konya (Eregli)und den anderen *Eurygaster*-Verbreitungsgebieten der Türkei angetroffen. Eine biologische Bekaempfungsmöglichkeit mit *T. semistriatus* gegen *Eurygaster* wurde noch nicht untersucht. Eine künstliche Grosszucht von *T.semistriatus* ist nach ZWÖLFER für Cilicien nicht wirtschaftlich.

Andere Parasiten, welche nicht wichtig sind, sind *Phasia crassipennis* F. (Dipt. Tachin.).

Clytiomyia helluo F. (Dipt. Tachin.).

Heteropogon ornatipes Loe (Dipt. Asilidae).

4. Bekaempfungsmassnahmen:

Die Bekaempfung von Getreidewanzen ist ein grosses und wichtiges Problem. Wir kennen verschiedene Bekaempfungsmassnahmen, welche ich hier ganz kurz erwaehnen möchte:

1) Die Bekaempfung auf den Getreidefeldern im Frühjahr: Diese geschieht in der Weise, dass man die Getreidewanzen auf den Aehren rechtzeitig absammelt und vernichtet. Diese Methode wurde seit vielen Jahren bei uns durchgeführt. Die Wanzen werden mit der Hand, Sieb, Insektennetz oder mit besonderen einfachen einheimischen Apparaten abgesammelt, in Flaschen, Krügen, Saecken oder Filzsaecken (Türkisch kil torba) eingefüllt, dann werden sie verbrannt oder tief im Boden begraben. Das Absammeln muss früh, also vor der Eiablage beginnen. Diese Zeit fällt bei uns in die Monate April-Juni. In manchen Orten bei uns werden die Aehren durch einen kleinen Holzstock auf eine einfache Blechschüssel, deren Raender etwa 3 cm nach oben aufgewölbt sind, abgeklopft, dadurch fallen alle Wanzen in diese Schüssel hinein, dann werden sie in die besondere Filzsaecke eingefüllt.

2) Nach der Ernte müssen die Körner mehrmals gereinigt und gewaschen werden. Auf dieser Weise werden viele angestochene Körner von den Gesunder getrennt. Viele Ackerbauer waschen das Getreide nach der Ernte zu diesem Zwecke ab.

3) Winterbekaempfung geschieht durch das Verbrennen der Getreidewanzen in ihrem Winterquartier auf den Bergen. Diese Methode wurde zuerst im Jahre 1923 durchgeführt in Persien.

Die Möglichkeit der Winterbekaempfung von Getreidewanzen wurde nach meiner Veranlassung zum ersten Male in der Türkei im Jahre 1944 waehrend des Monats August in den Südost Provinzen (Diyarbakir, Elazig, Tunceli) durchgeführt. Alle Astragalus, Acantholimon und andere solche Polsterpflanzen, unter welchen diese Wanzen haufenweise überwintern, wurden verbrannt. Diese Polsterpflanzen wurden mit Streichholz, Kienholz (Kiefernspan), Fackeln, mit Petroleum benetztem Holzstock oder Lappen mit Leichtigkeit angezündet und verbrannt und dadurch alle darunter uberwinternde Wanzen vernichtet. Die Anwendung von Flammenwerfern war nicht praktisch. Das

Herauftragen dieser Maschinen und von Petroleum war schwer. Ausserdem leisteten diese Maschinen nicht viel.

4) Frühreifende (Resistente) Weizensorten.

Die beste Methode und radikale Bekaempfungsmassnahme gegen Getreidewanzen ist der Anbau der frühreifenden Weizensorten. Oder das Ersetzen der Gerste könnte im Frage kommen, weil die Gerste früher reift als der Weizen. Waehrend der Ernaehrungszeit von Getreidewanzen werden die Körner vom frühreifenden Weizen haerter und können diese Insekten solche Körner nicht stechen und sterben vor Hunger.

In Cilicien wurden mehrere frühreifende Weizensorten gegen *Eurygaster*-schaden auf dem Felde versucht, sie sind aber bei uns bis heute für die Aufhebung von Wanzenschaden noch nicht allgemein verbreitet.

5) Fruchtwechsel:

Da die Hauptschaeden von Getreidewanzen besonders an Weizen vorkommen kann man in den Gebieten, wo die Wanzen massenweise vorkommen, statt Weizen für einige Jahre eine andere Feldpflanze anbauen, welche von Getreidewanzen nicht befallen wird. Im Jahre 1941 hatten die Ackerbauer ihre Felder, auf welchem Getreidewanzen im Jahre 1940 viele Schäden angerichtet hatten, statt mit Weizen, mit Mais, Hirsen und Leguminosenpflanzen bestellt. Vor der Anwendung dieser Fruchtwechselmethode ist mehrjaehrige ausführliche örtliche Beobachtung und Untersuchung dringend notwendig. Zusammengefasst kann man sagen, dass für heute nur zwei Bekaempfungsmethoden gegen Getreidewanzen in der Türkei anwendbar sind und zwar:

Erstens: Das Absammeln und vernichten von Getreidewanzen auf den Getreidefeldern.

Zweitens: Das Verbrennen dieser Insekten in ihren Winterquartieren im Gebirge.

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DISCUSSION

Mr. **Doeksen**: Fürchten Sie nicht dass durch Verbrennen der Pflanzenpolster, die Erosion stark zunehmen wird?

Mr. **Alkan**: Die Polster wachsen wieder in 2 – 3 Jahre, weshalb die Erosionsgefahr nicht grosz ist.

CARACTERES DES PULLULATIONS DU HANNETON COMMUN (M. MELOLONTHA L.) DANS L'EST DE LA FRANCE

par

A.COUTURIER
Colmar,France

l'Est de la France comprend des zones soumises aux trois régimes du Hanneton commun *(Melolontha melolontha* L.). De nombreuses observations effectuées ces derniers temps permettent de concevoir la manière dont évoluent les populations au cours des années.

Cette région présente des massifs forestiers importants entourés de nombreux pâturages propices au développement des Vers blancs. Les lisières irrégulières forment des indentations, des saillies et des angles avancés vers lesquels les Insectes se dirigent de préférence, surtout s'ils sont situés dans une position légèrement surélevée par rapport au reste du bois. Les bordures rectilignes et les creux sont moins fréquentés. Quelques chiffres donneront une idée du nombre d'individus pouvant se trouver rassemblés dans ces lieux privilégiés. Il suffit d'un Hanneton au mètre carré pour qu'une superficie de 1 kilomètre carré de terrain non boisé fournisse 1 million d'individus. Or, on trouve fréquemment 5 et parfois 12 insectes par unité de surface. On comprend de suite la foule considérable susceptible de se grouper au coin d'une lisière si l'on songe qu'elle provient des champs environnants dont l'étendue peut atteindre 2 à 3 km^2, et souvent plus.

A moins de disposer d'un relai (buissons, arbustes), les femelles pondeuses ne semblent guère s'éloigner au-delà de 1 km. de leur point de départ, surtout en terrain plat. Les sondages effectués à partir des lieux de rassemblement sur les arbres ont montré que les pontes les plus nombreuses se situaient dans une aire comprise entre 200 et 1.000 mètres du lieu d'envol. On constate une forte diminution en deçà comme au-delà. Dans cette zone critique la pose des femelles semble se faire au hasard avec de grandes variations d'un point à un autre, ce qui provoque les „taches" à Vers blancs bien connues des agriculteurs (3).

Les lieux les plus attaqués par les larves donnent rarement le plus de Hannetons. En 1946, dans le cours supérieur de la Saône (région de Monthureux, Vosges), les plus grands rassemblements avaient été observés dans les forêts situées au fond de la vallée. Les années suivantes les Vers blancs avaient causé des dommages énormes en détruisant beaucoup de prés. A l'automne 1947 la densité atteignait encore par endroit 70 au m^2, mais les trois quart se trouvaient parasités par un Nématode du groupe des Mermis (2). Le nombre des larves était tombé presque à zéro un an plus tard, aussi le vol de 1949 a présenté un aspect très différent du précédent. Les herbages qui avaient subi les plus graves attaques n'ont pas donné de Hannetons, ceux-ci sont sortis des pâtures plus éloignées situées sur le plateau où n'avaient pas été observés de dégâts sensibles. Les Insectes se sont grou-

pés sur les forêts du voisinage, délaissant les bois effeuillés trois ans auparavant car ceux-ci se trouvaient à une plus grande distance et en contrebas (1).

Au petit foyer simple (a) de Rouffach (Haut-Rhin), les sondages de l'automne 1949 ont donné un chiffre très élevé dans les parcelles ne présentant pas d'attaques apparentes (dans la parcelle No 2 la moyenne de 50 trous de 0.50 x 0.50, ouverts dans un hectare, donnait 17 Hannetons au m^2). Au contraire les insectes étaient moins abondants dans les prés montrant des taches où toute la végétation avait été détruite et la terre mise complètement à nu (No 10 : 4.2 Hannetons au m^2; No 4 : 5 au m^2; No 9 : 5.8 au m^2).

En 1950 dans le sud de l'Alsace (Sundgau) les Hannetons sont apparus relativement en petit nombre dans les communes où les cultures avaient été endommagées (Valdieu – Lutran), les grandes concentrations ont été observées à plusiers kilomètres de distance, à proximité des prés qui ne semblaient pas avoir souffert des larves. (Chavannes-les-Grandes).

Ainsi l'étude de différents foyers révèle une mortalité considérable des Vers blancs dans les endroits où la densité était très forte (supérieure à 60 au m^2). Des épizooties d'origine microbienne, ou encore provoquées par des Nématodes parasites, en détruisent un si grand nombre que très peu survivent. Les Hannetons sortent surtout des prés où les dégats sont peu visibles, ce qui correspond à une densité des larves probablement inférieure à 20 au m^2.

Dans une région déterminée les changements, ou les fluctuations, observés d'un cycle à l'autre des lieux de concentrations les plus denses, ne sont pas dus à des vols de migration des Insectes parfaits comme semble l'admettre une version populaire. Ils sont déterminés principalement par le taux de mortalité extrèmement élevé observé dans les terrains où il y a surpopulation.

Ce sont donc les sols moyennement contaminés, dans lesquels les larves se développent bien et ne provoquent pas de dégâts importants sur prairie, qui fournissent généralement le plus grand nombre de Hannetons. Ceux-ci apparaissent alors dans des localités où rien ne faisait prévoir leur pullulation. Par contre, les sites les plus éprouvés au cours du cycle précédent sont souvent épargnés.

(a) Nous avons défini *foyer simple*, un milieu naturel susceptible de permettre à lui seul le *développement permanent d'une population indépendante de Melolontha.* Ce milieu comprend un ensemble géographique essentiellement constitue par un groupement de feuilles avec les cultures attenantes dont la surface est limitée par la faculté de dispersion des femelles pondeuses (au plus 3 km). Son étendue restera donc faible. Il doit en outre être assez éloigné d'autres foyers pour évoluer pour son propre compte.

Un foyer est dit *multiple* lorsqu'il comprend des ensembles forestiers assez rapprochés pour permettre le mélange de leurs populations respectives au cours des vols préalimentaires ou pendant les vols de ponte. (3).

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DISCUSSION

Mr. **Breny**: Quelle est la base de l'établissement de places d'essai dans la détermination de population de hanneton?

Mr. **Couturier**: Tous les 100 m (en lisière par exemple) on établi perpendiculièrement à la direction choisie des trous de 0.75/0.75 m, établis tous les 10 m.

Mr. **Bernard**: A-t-on découvert une corrélation entre les points où l'on observe des sorties massives et ceux où la ponte se concentre?

Mr. **Couturier**: Oui, on constate que les insectes pour la ponte, retournent vers leur lieu de sortie.

Mr. **Geier**: Le masquage du saillant préférentiel a-t-il pour effet de faire converger les vols alimentaires sur les lisières immédiatement voisines du saillant masqué
a) en raison de leur proximité du point de rassemblement original ou b) par le fait que le nouveau but de vol se trouve, pendant le masquage du but primaire, dans la région considérée, le point le plus typiquement caractérisé du point de vue attractif?

En d'autres termes, le choix du nouveau point de rassemblement est-il conditionné par la localisation du point original, ou se fait-il sans relation avec ce dernier?

Mr. **Couturier**: Le choix du nouveau lieu de rassemblement ne semble pas dépendre de l'emplacement du point original. Les insectes se dirigent vers l'endroit le plus typiquement caractérisé de point du vue attractif; ce site pourrait être assez éloigné du premier.

à 400 – 500 m de l'écran les coléoptères changent brusquement de direction dès que le point de concentration initial a été masqué. Les insectes qui longent le nuage ont été surpris par la fumée alors qu'ils étaient déjà en course. Celle ci formait un rideau dépassant 500 m. et beaucoup d'entre eux se dirigaient primitivement vers un emplacement différent de celui marqué A;

en B par exemple on observe des arrivées notables, mais bien plus faibles qu'en A.

Mr. Horber: Bei den Engerlingsgrabungen im Jahre 1950 zur Kontrolle der Wirksamkeit der Maikäferbekämpfung bei Sulgen (Kt. Thurgau) konnten wir Beobachtungen machen, welche mit denjenigen des Referenten übereinstimmen. In den unbehandelten Vergleichsgebieten überwiegen in den Naturwiesen die Proben mit einem niederen Engerlingsbesatz (17 je m^2). Diese geringe Dichtigkeit scheint den Engerlingen hinreichenden Schutz vor Nahrungsmangel, Anstechung durch Krankheiten und Befall von Parasiten zu gewährleisten. In Parzellen mit grösserem Besatz (60 je m^2) konnte eine stärkere Mortalität festgestellt werden als in jenen mit niedrigem Anfangsbefall.

Wir müssen aus diesen Beobachtungen die Schlussfolgerung ziehen, dass Maikäferbekämpfungsaktionen gefährlich werden können, indem sie einerseits nicht wirksam genug sind, um den Engerlingsschaden vollständig zu verhüten, anderseits aber den anfänglichen Engerlingsbesatz so vermindern, dass die natürliche Mortalität langsamer und schwächer einsetzt als in den unbehandelten Gebieten.

Weiter ist es wichtig, dass die Maikäferbekämpfungsaktionen nur nach gründlichen Untersuchungen über die Populationsverhältnisse und die Stärke der natürlichen Mortalität im fraglichen Gebiete vorbereitet werden. Wenn solche Aktionen nur auf jene Gebiete beschränkt werden, wo in den Vorjahren starke Engerlingsschaden entstanden waren, ist es wahrscheinlich dass dort der Maikäferflug so schwach ausfällt, dass sich die Aktion gar nicht rechtfertigt, während dagegen in der Umgebung, wo man nicht vorbereitet ist die Maikäfer viel stärker auftreten.

ENSEIGNEMENTS A TIRER DES DERNIERES OPERATIONS HANNETONS

par
R.REGNIER
Rouen, France

La lutte chimique contre les Hannetons adultes pose un grand nombre de problèmes à la fois biologiques, toxicologiques et techniques que les grandes Opérations conduites en France depuis 1948[1] contre le Hanneton commun *(Melolontha melolontha* L. *)* ont permis en partie de résoudre.

Ces Opérations qui ont porté sur près de 120.000 hectares (Vexin Normand et Vosges 1949 – Alsace 1950 – Oise et Côte d'Or 1951) n'ont été possibles qu'avec la participation financière de l'Etat et de l'Institut Technique de la Betterave, particulièrement intéressé en raison des dégâts considérables causés par les Vers blancs dans cette culture. Il n'est pas rare en effet de voir les rendements en betteraves tomber à moins de 10 tonnes à l'hectare, parfois même à moins de 5 tonnes, quand le nombre des Vers blancs en année sèche dépasse 200 à 300 à l'are.

Devant les résultats obtenus, actuellement des groupements agricoles importants envisagent de prendre en charge de nouvelles Opérations. En raison des incidences que peut avoir cette lutte pour la solution des problèmes entomologiques du même ordre, il convient d'en souligner les différents aspects.

1° – *Sur le plan biologique.* La lutte implique des connaissances approfondies sur la Phénologie et l'Ecologie de l'insecte qui permettent d'évaluer à l'avance l'importance des populations, de prévoir la date et l'échelonnement des sorties printanières, de déterminer les mouvements des adultes en fonction des conditions météorologiques, de la nature et de l'état du sol et de la végétation.

La lutte implique également l'établissement de normes et de méthodes de contrôle pour guider les opérateurs, vérifier l'efficacité des traitements et apprécier la rentabilité de l'Opération.

La pratique des sondages en fin de l'été précédant les sorties de printemps dans les prairies naturelles ou artificielles s'est avérée profitable pour connaître la localisation et l'importance des populations.

La prévision des dates de sorties est subordonnée à l'exactitude des prévisions météorologiques à longue échéance qui, on le sait, sont encore très incertaines. Par contre l'utilisation des filets pour déterminer l'échelonnement des sorties s'est montrée efficace.

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1) R.Régnier – La destruction des hannetons par les traitements aériens et au sol. Historique des recherches françaises sur le Hanneton commun. *IInd Intern. Congres of Crop Protection.* London 1949.

Pour la préparation de l'Opération-Hanneton de l'Oise (régime 1) il fut exécuté en juillet-août 1950 (période de nymphose) des sondages dans des pièces de luzerne et des pâtures où aucune façon culturale n'avait été faite depuis la ponte de 1948, et qui constituent en principe ainsi des réservoirs à Hannetons. Chaque sondage consistait en un trou d'un mètre carré à une profondeur de deux fers de bêche; en général les loges sont au fond du premier ou en haut du second. Il a été pratiqué en moyenne 10 sondages par pièce à des intervalles réguliers.

Les sondages ont donné les moyennes suivantes: 400 Hannetoss à l'are dans les luzernes de plus de 2 ans, et 200 Hannetons dans les pâtures, mais dans certaines communes ces chiffres ont atteint 1200 et 1400. On est arrivé, en ne tenant compte que de ces deux cultures à une évaluation sur 60 communes de plus de 200 millions d'insectes, auxquels il fallait ajouter ceux qui pouvaient sortir des autres terrains.

Les sorties printanières et notamment les contrôles sous filets ont confirmé ces prévisions, malgré les grandes pluies hivernales et printanières.

Nous estimons que le chiffre des sondages doit être de 30 à 50 par commune. Nous considérons qu'il est très imprudent de préparer une opération sans essayer de connaître les conditions dans lesquelles les Hannetons ont pu effectuer leur développement, de multiples facteurs pouvant provoquer leur réduction: persistance de la sécheresse, intervention de maladies, de parasites et de prédateurs, en particulier des Campagnols qui en sont de grands destructeurs.

La période utile d'application des traitements dépend de l'évolution des ovaires. Le contrôle de l'état de ceux-ci est à la portée de tout opérateur averti, et doit être suivi pour traiter avant les vols de ponte.

L'interprétation des résultats repose sur la connaissance du seuil de nuisiblité des Vers blancs en fonction des cultures, et de l'importance des survivants et non des morts qui, avec les produits actuels, sont toujours nombreux.

2° – *Sur le plan toxicologique.* La lutte n'est possible qu'avec des produits dont les doses ont été bien étudiées suivant le mode d'application, et dont la persistance est suffisante pour résister aux intempéries.

Conformément aux indications du Laboratoire Central de Phytopharmacie, il a été surtout utilisé de l'Hexachlorocyclohexane (HCH) son dérivé sulfuré le sulfure de polychlorocyclane (SPC) et du Lindane (isomère gamma de l'HCH). Le Parathion (SNP) n'a été employé qu'à titre expérimental.

Dans la dernière Opération, on se servit pour la pulvérisation et l'atomisation de produits contenant 50% de HCH dont 13 à 14% d'isomère gamma et d'une émulsion contenant 15% de Lindane; et dans la nebulisation (fogging) de produits à base d'huile d'été contenant 50 grammes de Lindane par litre.

Les quantités épandues ont été en moyenne à l'hectare de 40 kgs de poudre (traitements aériens) de 10 kgs d'HCH 50 en pulvérisation, de 5 à 6 kgs d'HCH 50 en atomisation, de 5 litres de Lindane en nébulisation. Pour traiter efficacement un kilomètre de lisière, il faut compter une quantité triple de celle à l'hectare.

L'emploi sur de grandes surfaces de produits insecticides comme les organiques de synthèse pose des questions d'equilibres fauniques qui sont à l'étude, et nécessite des ententes préalables avec les groupements apicoles et piscicoles pour essayer de limiter les risques d'intoxication. Il est à noter qu'au cours des récentes opérations, aucun accident notable n'a été signalé, en raison de l'époque et des conditions d'exécution des traitements, dont tous les intéressés étaient informés à l'avance. Le Président du Syndicat apicole de l'Oise a exprimé par écrit sa satisfaction aux opérateurs, à l'issue de la dernière campagne.

3° – *Sur le Plan mécanique.* Toutes les méthodes ont été utilisées: pulvérisation, poudrage, atomisation, nébulisation, par de appareils au sol ou aériens.

Les pulvérisateurs gardent leur intérêt pour les traitements diffus (jardins, enclos, haies, pépinières, arbres isolés, petits bosquets) notamment dans les villages, et les poudreuses dans les régions ou l'approvisionnement en eau est difficile.

Les atomiseurs ont un rendement nettement supérieur et une portée plus grande, mais il semble qu'il y ait à partir d'une certaine distance une dissociation du produit, qui en atténue les effets: l'atomisation ne paraît pas être d'une efficacité certaine au-delà d'environ 15 mètres en profondeur dans les bois denses, elle est parfaite en lisière; le débit des appareils doit en outre être réglable, il y aurait intérêt à les doter ce deux buses, l'une traitant en bas pendant que l'autre traite en haut.

Nous disposions au printemps dernier de deux prototypes d'atomiseurs (type Beauvais de la Société Desbenoits-Jacquemin) dotés d'un moteur auxiliaire de 106 CV, et de projecteurs permettant de travailler de nuit. Ces appareils épandent 100 litres de bouillie par hectare et ont traité jusqu'à 38 km de lisière en une journée, mais en raison des révisions constantes nécessitées par leur mise au point la moyenne journalière fut de 22 km.

La nébulisation vient de rendre de grands services dans l'intérieur des bois en raison de la maniabilité des appareils de la portée étendue du brouillard (pénétration à 200 mètres). Son prix de revient est inférieur à celui des autres appareils mais les produits employés reviennent plus cher. Elle permet, nous l'avons dit, de traiter efficacement avec 5 à 6 litres de produit à l'hectare, ce qui facilite la traction par une Jeep.

Les traitements par avions sont rapides, mais imprécis. Ceux par hélicoptère sont précis, mais coûteux. La difficulté de trouver des pilotes d'helicoptère, de s'approvisionner en pièces de rechange, la nécessité de réviser constamment les appareils, les perfectionnements incessants apportés dans

la construction de ces machines délicates, posent de graves problèmes, techniques et financiers.

Il semble en outre que, par suite de l'irrégularité des futaies, la diffusion des produits ne soit pas régulière et que les courants aériens ascendants empêchent d'atteindre à certains moments une partie du feuillage.

Nous devons ajouter que l'utilisation des appareils aériens est étroitement liée aux conditions atmosphériques, et notamment à la vitesse du vent. Au printemps les hélicoptères n'ont pu effectuer que 17 sorties et 42 heures de vol pour traiter un millier d'hectares. Il y eut 14 sorties le matin (entre 5 et 9 heures) contre 3 le soir (entre 18 à 20 heures 30) tandis que les appareils au sol peuvent en principe travailler quand il ne pleut pas ou quand le vent n'est pas trop violent.

La combinaison des méthodes est recommandable; la nébulisation paraît appelée à un grand avenir, mais une mise au point s'impose, notamment pour le réglage du débit en fonction de l'importance des bois à traiter. Quant aux traitements aériens, si utiles dans le cas d'accès difficile des bois, ils présentent pour le Hannetonnage chimique des inconvénients auxquels l'amélioration des techniques permettra, nous l'espèrons, de remédier.

4° – *Sur le plan de l'exécution.* Dans les conditions économiques actuelles, les régions de plaines semées de boqueteaux et les grandes enclaves forestières offrent les conditions les plus favorables aux Opérations; les zones bocagères, marécageuses ou trop boisées, ou d'accès difficile sont défavorables.

Le travail de nuit des atomiseurs ne nous a pas donné les résultats que nous en attendions; outre que le personnnel ne voit pas très bien ce qu'il fait, le matériel risque de se trouver en difficulté en terrain accidenté ou trop humide. Il est préférable de commencer au petit jour et de terminer à la nuit tombante, en utilisant deux équipes qui se relaient.

En raison des variations climatiques et écologiques, il est préférable de conduire parallelement et simultanément plusierus opérations de moyenne importance (10.000 à 15.000 hectares) plutôt qu'une opération unique sur une grande étendue, (40 à 60.000 hectares). Dans notre Opérations de l'Oise, la superficie de la zone à traiter était de 62.670 hectares avec 6.860 hectares de bois et de vergers. Nous avons noté, trois situations climatiques différentes qui ont nettement influencé les traitements: dans la zone A, côté vallée de l'Oise, terrains éocènes, les sorties ont été en général plus précoces qu'au Nord-Ouest du grand Massif de Hez, en direction de Beauvais (zone B) et surtout que dans le secteur en bordure du plateau picard (zone C) de formation crétacée où les sorties ont été les plus tardives (après le 15 mai). Il en est résulté des difficultés d'exécution qui auraient été atténuées, si nous avions prévu trois opérations distinctes.

Il faut en outre préparer l'Opération plusiers mois à l'avance, pouvoir disposer d'un personnel qualifié et entraîné, avoir affaire pour les appareils à

grand travail à une seule entreprise responsable de l'Opération, établir un cahier des charges qui la lie au contrat, s'assurer de la participation effective des Agriculteurs pour le traitement des villages et des foyers isolés (fourniture de main d'oeuvre, de moyens de traction et de petits appareils) prévoir en raison de l'échelonnement des sorties et des incertitudes actuelles de leurs dates trois périodes de traitement:

1 une période d'alerte (15 au 25 avril) où on peut intervenir en cas de nécessité avec des moyens locaux.
2 une période de grands traitements (25 avril au 15 mai) où il faut agir avec des moyens exceptionnels.
3 une période de sécurité (15 au 31 mai) pour effectuer des traitements complémentaires, avec les moyens locaux et éventuellement des nébuliseurs.

5° – *Sur le plan financier.* Les Opérations Hannetons sont normalement à exécuter sur des superficies étendues et de ce fait nécessitent des moyens puissants; si l'on n'est pas en mesure d'engager ces dépenses importantes, il faut renoncer à l'Opération, car mieux vaut ne pas la tenter que de la faire imcomplètelent, étant donné qu'il ne s'agit pas seulement de tuer des millions de Hannetons, ce qui est toujours possible avec les techniques actuelles, mais de diminuer leur population de façon telle que le seuil de nuisibilité ne soit pas atteint dans les cultures à protéger.

En plus du coût des traitements mêmes, il faut prévoir les dépenses occasionnées par les sondages, la préparation de l'Opération, les contrôles de sorties et des survivants, l'immobilisation des appareils (qui peut être considérable pour les appareils aériens), les déplacements du personnel, les frais de traction, les traitements d'extinction: (une marge de 25% paraît nécessaire).

Quant au prix de revient, il varie avec l'importance de la surface boisée à traiter par rapport à l'étendue des terres cultivées à protéger. Dans les opérations effectuées il a été de l'ordre de 5.000 francs (français) l'hectare traité, de 15.000 francs envirion le kilomètre de lisière, et de 400 francs l'hectare protégé (500 fr avec la marge de 25 pour cent).

Il est possible que l'emploi des nébuliseurs permette dans l'avenir, en raison de la rapidité d'exécution, d'abaisser sensiblement ce prix. Quand on songe qu'une seule attaque massive de Vers blancs peut occasionner en grande culture des pertes de l'ordre de 10.000 à 12.000 francs à l'hectare, on voit que, même actuellement, la lutte est rentable. Mais comme il s'agit, en fait, d'un traitement préventif, il est probable que les milieux agricoles seront longtemps réticents pour l'effectuer.

En résumé le hannetonnage chimique ne peut être envisagé que dans des cas bien déterminés et avec des moyens appropriés et puissants. Malgré les résultats obtenus, bien des problèmes restent à résoudre tant au point de vue biologique que technique. Notre Service met tout en oeuvre pour y parvenir.

Summary
The large-scale control applications directed against Cockchafers in France since 1948 have encompassed more than 120.000 hectares (over 300.000 acres); they have allowed us to solve part of the biological, toxicological and technical problems set to us by the massive occurrence of Cockchafers (*Melolontha melolontha* L.). We have been able to gather from them the following instructions:

1° – *On the biological ground:*

– Necessity of a thorough knowledge on the Phenology and Ecology of the Cockchafers in order: to be able to evalue and forecast the importance of the emergences (method of sounding-diggings into the ground at the end of the summer preceding the emergences)

– the likely date and ranging of the emergences (need be of a still more accuracy in the weather forecasts, and of phenological vegetal marks)

– the motions and progress of the adults (in function of the climatic and natural conditions and of the nature and condition of the soil and the vegetation).

– the planning of normal and checking methods so as to guide the operators, to test and verify the efficiency of the treatments and interpret the results (evaluation of the surviving insects, determination of the noxiousness-threshold)

2° – *On the toxicological ground:*

– Necessity of getting stable chemicals and to study thoroughly their proportional dosage and sufficient persistency Pre-agreements with Bee farmers.

3° – *On the mechanical ground:*

– Spraying and dusting machines must be advised for scattered treatments (gardens, enclosures, hedges, nurseries, limited outskirts). The aeromist sprayers are more efficient and have a widerrange of action but they must be regulated so as to prevent the dissociation of the chemicals over 20–25 meters – Very efficient on outskirts

– Fogging machines are easier to drive and have a wide range of action, they allow the control inside woods but the price of cost of the chemicals they used is higher.

– The control of large woody areas is quick by aerial spraying machines but it lacks accuracy, the appliance is restricted and closely related to the climatical conditions especially to the wind velocity.

– The helicopter is accurate but expensive. Its use is also restricted and and the problems of piloting it and that of spare parts are diffucult to solve.

The combination of all these methods of control is advisable. Fogging seems to be marked out for the future but the methodneeds to be worked out.

4° – *On the working ground:*

– Flat countries, large areas encompassed by forests are the most favourable for the control treatments. It is best to divide them into several more limited ones (from 10.000 to 15.000 hectares at the utmost) (25000 – 37.500 acres) A qualified and trained staff must be in readiness; only one responsible firm must be managing the actions; for the aerial machines three periods must be forseen: a look out one; an application one, with all exceptional means of control available, and a safety one for the completion of the treatments.

5° – *On the financial ground:*

In addition to the cost of the treatments, must be foreseen the expenses caused by the diggings, the preparation of the action, the immobilization of the machines, especially the aerial ones, the travels and moving about of the techniques, the driving and pulling of the machines and the completive treatments. (margin of 25%).

The cost is function of the relative importance of the woody areas to the cultivated ones: in the control operations carried on up to now, it has reached an average of 5000 French francs per treated hectare (about 2.5 acres) and 400 fr per protected one.

DISCUSSION

Mr. **Vleugel**: Est-ce qu'on ne détruit pas beaucoup de nids d'oiseaux utiles avec votre méthode de lutte contre les hannetons?

Mr. **Regnier**: Avec la pulvérisation en jet direct il y a des inconvéniants incontrôlables, mais au cours de nos opérations, les accidents ont été très rares; d'après les contrôles du service d'ornithologie, avec l'atomisation et la nébulisation à l'hexa, il ne semble pas y avoir de danger; si nous nous en rapportons à la dernière campagne: les corbeaux-freux (Corvus frugilegus) qui nichent en bandes, n'ont pas souffert des traitements.

Mr. **Vayssière**: Est-ce que Mr. Régnier a pu constater si les traitements des lisières ont eu une action insectifuge, provoquant le déplacement massif des Hannetons vers les vergers? Ceci a été observé en Suisse.

Mr. **Regnier**: Non, l'action insectifuge n'a jamais été constatée. Mais les traitements n'ont été opérés qu'avec le H.C.H. et pas du tout avec du D.D.T., comme en Suisse.

KANN DIE BEKÄMPFUNG DES MAIKÄFERS MIT CHEMISCHEN MITTELN EINE ENGERLINGSPLAGE BESEITIGEN?

von

S. BOMBOSCH

Frankfurt am Main, Deutschland

Kann die Bekämpfung des Maikäfers mit chemischen Mitteln eine Engerlingsplage beseitigen? Diese so häufig verneinte Frage möchte ich für Bekämpfungen in der Ebene mit einem vollen Ja beantworten. Der Entwicklungszyklus des Maikäfers lässt sich im Imaginalstadium wirksam unterbrechen, und nicht nur wirksam, sondern auch äusserst wirtschaftlich und ohne nachhaltige Vergiftung irgendeines Teiles des Waldes. Welche Methoden zu diesem Ziel geführt haben, möchte ich Ihnen nachfolgend kurz schildern:

Als Beispiel soll die Bekämpfung dienen, die wir 1950 unter dem Protektorat von Herrn Oberforstmeister RUPPERT im Stadtwald von Frankfurt am Main durchgeführt haben. In diesem 3.700 ha grossen Wald hatten Katastrophen, starke Schäden hervorgerufen. 34% des Waldes wurden zerstört und auf 1.255 ha Kahlflächen hielt der Engerling seinen Einzug. Da es von vornherein ausgeschlossen war, auf diesen grossen Flächen eine Totalentseuchung des Bodens durchzuführen, musste die Voraussetzung für eine Wiederaufforstung durch eine Imagobekämpfung geschaffen werden. Diesem Vorhaben standen die waldbaulichen Verhältnisse nicht gerade günstig gegenüber. Etwa 50% des Stadtwaldes sind reine Laubholzbestände mit Durchschnittshöhen bis zu 40 m, die übrigen 50% Kiefernbestände mit Buchenunterbau.

Neben diese Schwierigkeiten trat ausserdem der Umfang des Brutgebietes des Maikäfers. Es beschränkte sich nicht auf die Kahlflächen, sondern drang tief in die Altbestände ein und konnte zuweilen sogar in dichten Laub- und Nadelstangenhölzern festgestellt werden. Mit einer Konzentration des Schwarmes an den Waldrändern durfte demnach kaum gerechnet werden, zumal es sich hier um *Melolontha hippocastani* F. handelte. Diese Vermutung bestätigte sich später vollends.

Es war klar, dass bei der starken Durchlöcherung des Waldes, dem Vorkommen niedrigster Naturverjüngungen neben 40 m hohen Altholzbeständen und dem grossen, weitverbreiteten Brutgebiet des Käfers eine gründliche Vorbereitung der Bekämpfung vorausgehen musste.

Als erstes führten wir in abgeänderter Form die von PUSTER empfohlenen waldbaulichen Massnahmen durch. Die Waldränder wurden begradigt oder abgerundet, einzelstehende Bäume jedoch auf ein Minimum reduziert. Hierdurch verhinderten wir eine weitere Verzettelung des Schwarmes auf einzelne, kostspielig zu behandelnde Bäume.

Als nächstes trat die Frage der Begiftungsmethode und daraus resultierend

die Art und Zahl der Geräte sowie die Wahl des Giftes an uns heran. Wir entschlossen uns, das Schwergewicht auf die Stäubung zu legen und nur die Behandlung einzelner Bäume sowie die Begiftung der Waldränder in der Nähe blühender Obstbäume zur Vermeidung von Bienenschäden dem Sprühverfahren zu überlassen.

An Geräten setzten wir für niedrige Büsche und Bäume Rückenschwefler ein. In grosseren Naturverjüngungshorsten und Stangenhölzern bis 10 m Höhe arbeiteten tragbare Motorverstäuber. Jedem Gerät waren etwa 50 ha zugewiesen. Die durchschnittliche Tagesleistung betrug 8 ha. Pferdegezogene Grossverstäuber waren bei Baumhöhen bis 20 m im Einsatz. Ihr Arbeitsgebiet war etwa 200 ha gross, ihre durchschnittliche Tagesleistung 23 ha. Die beste Arbeit leistete ein amerikanischer Aero – Mist Sprayer, Modell L 80. Bei einem Einsatzgebiet von 400 ha betrug die durchschnittliche Tagesleistung 46 ha, die Spitze 90 ha. Bis 45 m hohe Bestände wurden bei normalem Stäubewetter genau so gut begiftet wie Naturverjüngungen. Die Abhängigkeit vom Wind war weit geringer als bei den anderen Geräten. Ausserdem war Stäuben und Sprühen mit demselben Gerät möglich. Besondere Betonung verdient auch noch sein äusserst geringer Giftverbrauch. Als Gift verwendeten wir ein 0.65% Gamma enthaltendes Rohhexastäubemittel sowie eine Emulsion, die 5%ig ausgebracht wurde.

Es mag eigenartig erscheinen, bei der Vielzahl moderner Begiftungsverfahren das Schwergewicht einer Maikäferbekämpfung auf die altmodische Verstäubung zu legen und von den neueren Verfahren nur die Sprühung zu wählen und diese wiederum nur für kleine Spezialaufgaben. Der Grund hierfür war folgender: Ziel einer Maikäferbekämpfung ist, den Wald von einem sich in Massenvermehrung befindlichen Schädling zu befreien. Dieses Ziel aber durch eine wochen- wenn nicht gar monatelange Entvölkerung des Waldes von allen seinen freilebenden Insekten zu erreichen, erscheint uns als ein äusserst zweifelhafter Erfolg. – Wir halten es für wichtig, mit Gift äusserst sparsam umzugehen und es nur kurze Zeit im Walde wirken zu lassen. Beim Sprühverfahren beschränkten wir es daher auf einzelne Bäume; bei der Stäubung verwendeten wir nur ganz geringe Mengen. Bei einer einmaligen Bestäubung mit dem Aero-Mist-Sprayer verbrauchten wir im Durchschnitt nicht mehr als 15 kg je ha, das waren bei unserem Präparat 100 gr Gamma. Die Nachhaltigkeit dieser Begiftung war selbstverständlich äusserst gering, aber die anwesenden Maikäfer waren vernichtet. Mehr wollten wir nicht. Wie diese geringe Menge wirkt, ist uns im Augenblick noch ein Rätsel, und ob sie auch bei reinen Waldrandbestäubungen ausreichend ist, können wir nicht sagen. Auf jeden Fall dezimiert sie innerhalb der Bestände die Maikäfer völlig ausreichend. – Bei einem erneuten Anflug wurde die Begiftung in gleicher Weise wiederholt. Der durchschnittliche Endverbrauch war aber ebenfalls sehr gering. Er betrug knapp 40 kg, das sind 260 gr Gamma je ha.

Bei der Durchführung der Bekämpfung hielten wir uns an kein starres Schema, sondern begifteten die Maikäfer überall, wo sie sich zum Frass niedergelassen hatten. Um ein genaues Bild über die Verteilung der Käfer zu erhalten,

wurde jedem Gerät ein Spürer beigegeben, der jeden Abend den Schwarm der Käfer beobachtete und Ansammlungen sofort meldete. Als Mass für die Stärke des Schwarmes nahmen wir die Zahl der Käfer, die innerhalb von 2 Minuten über eine gedachte Linie flogen. Gleichzeitig diente uns diese Auszählung als vorläufiges Ergebnis über die Wirkung unserer Bekämpfung. Wir brachen sie ab, wenn wir 20–25 Käfer zählten. Auf Auszählungen toter Maikäfer legten wir für die Erfolgskontrolle keinen Wert. Nur die Überlebenden sind für die Kulturflächen von Bedeutung. Selbstverständlich haften auch dieser Methode einige Fehlerquellen an, und vieles ist dabei Gefühlssache, doch meinen wir, dass sie besser ist, als die sehr relativen Begriffe „stark" und „schwach", und Totenzahlen sagen auch nicht viel, da die absolute Zahl der Maikäfer wohl stets eine grosse Unbekannte bleiben wird.

Die Kosten betrugen für eine einmalige Behandlung eines Hektars beim Aero-Mist-Sprayer 10.30 DM, beim pferdegezogenen Motorverstäuber 17.80 DM und beim tragbaren Motorverstäuber 24.30 DM. Im Endeffekt kostete die Behandlung eines Hektars 35.50 DM. Umgerechnet auf den Hektar geschützter Kulturflächen machten die Kosten 67,– DM aus. Dieser relativ hohe Betrag kam daruch zustande, dass wir zum Schutz der 1.255 ha Kulturflächen, 2.400 ha Wald bestäuben mussten. Trotzdem machen aber diese Kosten nur ca 50% der Teilflächenbegiftung einer Engerlingsbekämpfung aus, ganz zu schweigen von einer Totalbegiftung, die bei uns allein durch die Stockrodung mit 1.000.– DM je ha vorbelastet ist.

Die endgültige Erfolgskontrolle haben wir im Herbst 1950 an Hand von Probegrabungen durchgeführt. 3.218 Einschläge vom 1 qm Grösse ergaben einen Durchschnittsbesatz von 7.6 Engerlingen Stadium I je qm. Vergleichen wir dazu den Durchschnittsbefall von 3.6 Maikäfer je qm im Herbst 1949, gewonnen auf Grund von 1.848 Einschlägen, so sehen wir, dass die Zahl der Jungengerlinge nur doppelt so hoch ist wie die Ausgangsbevölkerung; mit anderen Worten, durch unsere Bekämpfung haben wir fast das erreicht, was die natürlichen Mortalitätsfaktoren während des ganzen Entwicklungskreises zustande bringen. Auf unsere Kulturflächen bezogen bedeutet dieses Ergebnis, dass nach der Bekämpfung rund 77% der Flächen gegenüber 11% im Frühjahr 1947 ohne Engerlingsgefährdung sind.

Abschliessend möchte ich noch erwähnen, dass wir in diesem Frühjahr in der Pfalz bei einer Versuchsstäubung auf 100 ha zu denselben Ergebnissen wie im Vorjahr gekommen sind. Auszählungen des Totenfalls anderer Insekten haben dabei ausserdem gezeigt, dass eine Wiederholung der Bestäubung nach drei Tagen nur 20.8% weniger Insekten auf die Fangtücher brachte als die erste Begiftung. Wir haben somit in der Bestäubung eine Methode in der Hand, die eine wirtschaftliche Bekämpfung der Maikäfer ermöglicht, ohne dabei eine nachhaltige Entvölkerung des Waldes von seiner übrigen freilebenden Insektenwelt herbeizuführen.

OBSERVATIONS PRELIMINAIRES SUR LE DETERMINISME DE L'ORIENTATION DES VOLS CREPUSCULAIRES DU M.MELOLONTHA

par
A. COUTURIER et P. ROBERT
Colmar, France

Au cours du printemps 1951 nous nous sommes livrés à quelques expériences en vue de connaître le déterminisme de l'orientation des vols crépusculaires du Hanneton commun (*Melolontha melolontha* L.), en procédant au masquage d'une lisière forestière à l'aide de rideaux de fumée artificielle.

Nous avons opéré en Bourgogne aux environs de Dijon (Côte-d'Or) à proximité d'un lieu de concentration des insectes parfaits. Il s'agissait d'une simple indentation de la bordure Ouest de la grande forêt de Longchamp, au point où elle atteint le rebord d'un plateau dominant la large vallée des Tilles au Nord de Genlis.

Les pots fumigènes utilisés proviennent des „surplus américains"; ils permettent de produire rapidement une abondante fumée de teinte blanchâtre, qui, selon la vitesse du vent, s'étale en nappe à la surface du sol ou forme un rideau vertical de 20 mètres d'épaisseur et dont la longueur peut atteindre 1 kilomètre. Le nuage ainsi formé est suffisamment haut et dense pour masquer toute une forêt. A la tombée du jour il se confond avec la couleur du ciel.

Les appareils placés à une certaine distance de la lisière (20 à 150 m) ont été disposés de manière à cacher la partie du bois où nous avions observé, les jours précédents, les arrivées les plus nombreuses. La fumée ainsi produite n'incommode pas les Hannetons et ne provoque pas leur fuite. Les expériences commencées pendant les vols crépusculaires préalimentaires des premiers jours de Mai, ont été reprises au moment des vols crépusculaires de ponte des 12 et 13 Mai (1).

Expérience No. 1 – ler Mai 1951

Ciel dégagé; température de l'air: 12°4; humidité: 65; vent: E.N.E. presque perpendiculaire à la lisière, vitesse 32 mètres à la minute.

20 h.14: début des arrivées à l'angle *A* du bois (17 Hannetons à la minute).

20 h.20: mise en action des pots fumigènes placés en 1 à 20 metres à l'Est de *A* et à 10 mètres en avant de la lisière. Le nuage qui masque le bois s'étale en nappe en raison de la faible vitesse du vent. Les insectes évitent la fumée dont ils suivent les bords.

20 h.25: très fortes arrivées en 1', près du point de départ du nuage et à la limité de la partie visible de la forêt (200 a 300 H.min.).

(1) Opérations effectuées avec le concours de MM. ANTOINE et BLAISINGER, Agents techniques.

Pendant ce temps les arrivées deviennent très faibles à l'angle protégé *A* (10 H. min.).

Expérience No 2 – 2 Mai 1951

Ciel couvert 2/10 au couchant; temp. air: 12°2; humid.: 83; vent: N. parallèle à la lisière, vitesse 80 m. min.

20 h. 10: début des arrivées.

20 h. 17: les arrivées deviennent rapidement très fortes, elles dépassent 100 H. min à l'angle *A* du bois.

20 h. 20: allumage des pots fumigènes placés en *2* à 60 mètres au Nord du point de concentration *A* et à 20 mètres en avant de la forêt. La fumée se développe selon un rideau parallèle à la lisière et de 15 à 20 metres de largeur. Il dépasse 500 mètres de longueur et il masque bien les arbres y compris presque toutes les cimes.

Cet écran provoque immédiatement un changement de direction du vol. Les Hannetons, au lieu d'aller vers *A*, s'orientent plus au Nord vers l'extrémité de la partie boisée encore visible et non masquée par la fumée: 2'.

D'autres insectes, surpris dans leur parcours, longent ce rideau en se dirigeant vers son origine. Ils arrivent en nombre considérable en cet endroit *2* (environ 500 min.), alors qu'aucun ne parvient au point de concentration primitif *A*, ni tout le long de la partie cachée par le nuage (fig. 1).

20 h. 44: arrêt de l'émission de fumée. Les arrivées se font à nouveau à l'angle *A* devenu visible. Elles peuvent être evaluées à 100 H. min., alors qu'elles deviennent presque nulles en 2' où elles étaient si nombreuses quelques instants auparavant.

20 h. 50: vol terminé.

Expérience No 3 – 3 Mai 1951

Temps orageux, ciel couvert 7/10; temp. air: 14°; humid.: 84; vent: S, vitesse 160 m. min.

20 h. 10: premières observations concernant le départ des femelles vers la la plaine pour la ponte.

20 h. 15: début des arrivées en forêt.

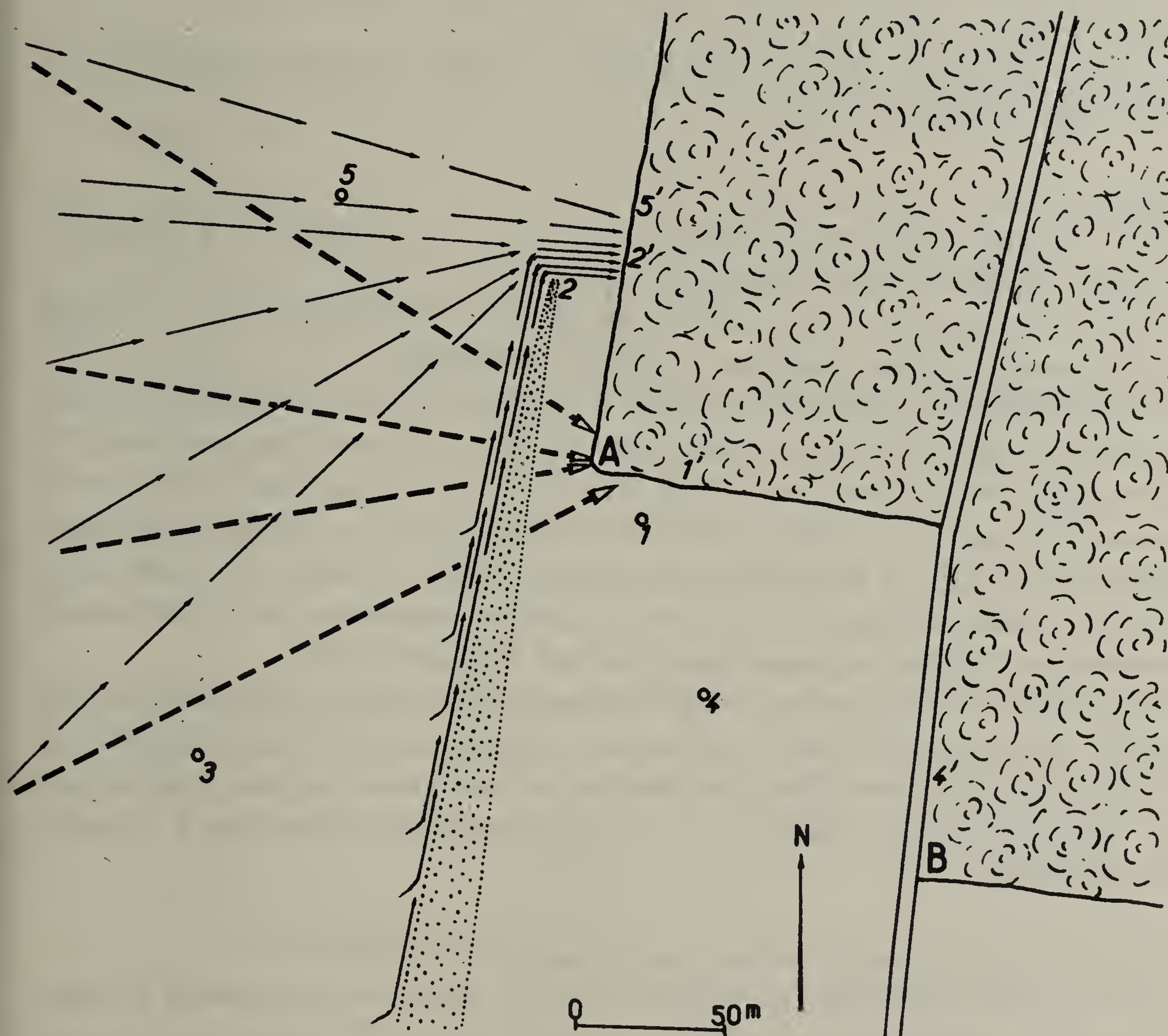
20 h. 25: allumage des pots fumigènes en *3* à 150 mètres en avant de la forêt, nuage peu dense de plus de 1 kilomètre de long parallèle à la lisière qui est totalement masquée.

Au début les insectes traversent le rideau encore transparent puis, lorsque celui-ci est bien formé, ils semblent desorientés car la forêt n'est plus visible. Quelques uns pénètrent dans le nuage, d'autres s'élèvent au-dessus; la grande majorité, après avoir tournoyé, longe le rideau de fumée vers le sud, c'est à dire contre le vent. Les arrivées cessent rapidement.

Expérience No 4 – 4 Mai 1951

Ciel couvert 3/10; temp. air: 11°6; humid.: 75; vent: S.E., vitesse 55 m. min.

20 h. 16: début des arrivées.



Masquage de forêt à l'aide de pots fumigènes (expérience No 2).

Les flèches doubles indiquent la direction des vols crépusculaires préalimentaires avant et après le masquage de *A* par le rideau de fumée.

Les flèches simples donnent la direction prise par les Hannetons en présence de l'écran de fumée.

Les numéros précisent les emplacement des pots fumigènes et en ' les nouveaux points de concentration correspondant lors des expériences 1,2,3,4 et 5.

20 h.20: allumage des pots en 4 à 50 m vers l'Est de la corne *A* et à 70 m. en avant de la lisière. La fumée recouvre complètement *A*. Les insectes qui arrivaient vers *A* changent de direction près de l'écran et longent le rideau de fumée pour aboutir en *4'*, à proximité de l'angle *B* situé de l'autre côté de la route.

A une plus grande distance de l'écran un certain nombre d'insectes se dirigent directement vers *B*.

Expérience No 5 — 12 Mai 1951.

Ciel dégagé: temp. air: 11°4; humid.: 70; vent: N, vitesse 30 à 40 m. min.

20 h.05: début du vol de ponte.

20 h.10: allumage des pots en 5 à 100 m. de la lisière et à 80 m. au Nord de *A*. Le nuage s'élève très haut et avance lentement.

Vol de sortie très dense (150 H.min.). Les femelles ne modifient pas leur direction au départ du bois. Comme nous l'avions observé d'autres soirs, le vol de ponte est orienté vers l'W.S.W., c'est à dire dans une direction légèrement oblique à la lisière principale dirigée N.S. Les insectes ne cherchent pas à monter, ni à obliquer, en arrivant devant le rideau de fumée mais, après une légère hésitation (quelques individus tournoient et ralentissent), ils traversent l'écran et poursuivent leur vol de l'autre côté.

20 h.30: fin du vol de ponte, début des arrivées en forêt. Le phénomène déjà observé se renouvelle dans les mêmes conditions que dans l'expérience No 2. Les arrivants modifient la direction du vol et se dirigent vers la portion de lisière restée visible en 5'. Ils passent très nombreux à la naissance du nuage.

Ces observations nous amènent aux conclusions suivantes:

a) Vols préalimentaires (expériences 1 à 5). En plaine, au moment de prendre son vol, chaque insecte décrit plusiers spires d'orientations à rayons de plus en plus grands, puis il se dirige vers un endroit déterminé. Ce *site préférentiel* est le même pour presque tous les individus qui partent d'un même lieu. Il correspond le plus souvent à un bord de forêt se détachant bien sur l'horizon et dont la situation semble indifférente par rapport au soleil couchant. Pendant son vol l'insecte continue à être en rapport avec l'objet qui le sollicite. Si ce pôle d'attraction se trouve caché par un rideau de fumée qui se confond avec le ciel, le Hanneton se dirigera vers son homologue, c'est à dire à la limite de la partie restée visible de la forêt. En la circonstance les insectes subissent l'attirance d'un ensemble formant tache où se produit un arrêt dans l'émission de radiations pour certaines desquelles au moins notre oeil est sensible, mais auxquelles le nuage forme obstacle.

Le vol crépusculaire préalimentaire paraît bien traduire un phénomène voisin du scototactisme „caractérisé par la recherche d'une ombre bien

délimitée analogue à la recherche d'un contact" (PIERON 1941) (1).

b) Vol de ponte (expérience No 5). La direction du vol n'est pas modifiée par un rideau de fumée placé à 100 m. de la lisière. Les insectes le traversent et continuent de l'autre côté à voler vers la plaine. Le vol de ponte semble plus complexe à analyser que le vol d'arrivée en forêt. Il est généralement dirigé en sens inverse de celui-ci, mais son stimulus n'est pas de même nature car il n'est pas influencé par la fumée.

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(1) Le scototactisme peut se combiner avec un phototropisme négatif comme chez Carcinus (Crustacée décapode) (ALVERDES 1930), et chez *Forficula* (Dermaptère) (KLEIN 1934), ou avec un phototropisme positif comme l'a observé WEYRAUCH (1936) chez *Notiophilus* (Coléoptère Carabide).

OBSERVATIONS SUR LA MOUCHE DES CHOUX ET SES PARASITES

par

J. VAN DEN BRANDE et J. VERBEKE

Gand, Belgique

Summary

1. La mouche

L'apparition des mouches se fit ou début du mois de mai pour l'année 1950. Les premières pupes se formèrent à la fin du mois.

3.500 pupes de *Chortophila sp.* ont été récoltées ou début du mois du juin. Les premières éclosions de mouches se sont produites le 12 juin: deux espèces étaient représentées: *Chortophila brassicae* Bché et *Ch. florilega* Zett.

Chortophila florilega ne représente que 5,5% de toutes les mouches écloses. Tandis que l'éclosion de *Ch. brassicae* se prolongea jusque fin septembre, les derniers adultes de *Ch. florilega* apparurent le 11 juillet.

Les pontes de la seconde génération, dont 500 nymphes ont été récoltées, eurent lieu vers la mi-juillet.

Le pourcentage de *Ch. florilega* était de 8%.

La génération hivernante n'a pas été étudiée.

2. Les parasites

Les pupes nous ont fourni deux espèces de parasites: *Aleochara bilineata* Gyll. et *Cothonaspis rapae* Westwood (d'après Ferrière).

Pour la première génération le degré de parasitisme s'élevait à 37,5%: *Aleochara bilineata* Gyll. représente 54,5% des parasites éclos, *Cothonaspis rapae* Ww. 45,5%.

En ce qui concerne la seconde génération le degré de parasitisme atteignait 47.8% dont 92.5% d'*Aleochara* et 7,5% de *Cothonaspis*.

THE REACTION OF THE INTRODUCED JAPANESE BEETLE TO CLIMATIC CONDITIONS IN THE UNITED STATES

by

IRA M. HAWLEY

Moorestown, N.J., U.S.A.

(read by F.C.Bishopp)

The Japanese beetle (*Popillia japonica* Newm.) is a beautiful green and brown scarabaeid which was first found in the United States in 1916 in a nursery in New Jersey, not far from Philadelphia, Pa. (Fig. 1). It was soon realized that the insect was of foreign origin and that it was rapidly increasing in numbers and threatened to become a serious pest. An effort was made to eradicate it, but this was soon found to be impossible. By 1935 the beetle had spread over an area of more than 11.000 square miles, and by 1950 this area had increased to over 53.000 square miles. All or parts of 10 eastern states are included in what is termed the area of general distribution, shown as a lined area on the map (Fig. 2). There are beetle colonies beyond this area in what is termed the outer zone of spread. In some of these colonies, marked by triangles on the map, beetles have been established for a long time and are now present over large areas. Localities where only a few beetles have been found in small areas are shown by dots. The point of introduction, near Philadelphia, is shown by the central round dot. The behavior of the insect in this area will be described and also that at a northern point in New England and a southern point in Virginia, shown by the other dots.

Influence of climatic differences on the seasonal cycle. Information as to the time of emergence of the adult beetle and its relative abundance during the summer has been obtained largely by specially designed bait traps. The status of the soil-inhabiting stages at different times of the year has been ascertained by making soil surveys and by examining many l-square-foot samples to determine the number of individuals in the different stages. These surveys have furnished information as to the time of transformation, the variation in numbers from year to year, and the action of biological and ecological influences on the insect (4)*. The seasonal cycle in the Philadelphia area is shown diagrammatically in Figure 3. The first beetles are normally found about June 17, but there may be a variance of a week or more from this date if the weather is abnormal. By early in July beetles are usually present in considerable numbers, and by late in July or early in August they reach their peak of abundance. Relatively few are found after the early part of September. Mating takes place soon after emergence, and the females enter the soil from time to time for egg deposition. Each female lays about 50 eggs during her life span of 30 to 45 days. The eggs hatch in about 2 weeks and

* Numbers in parentheses refer to Literature Cited.

Fig. 1. An adult Japanese beetle. The white tufts of hair on the sides and at the caudal end of the abdomen are characteristic of this species.

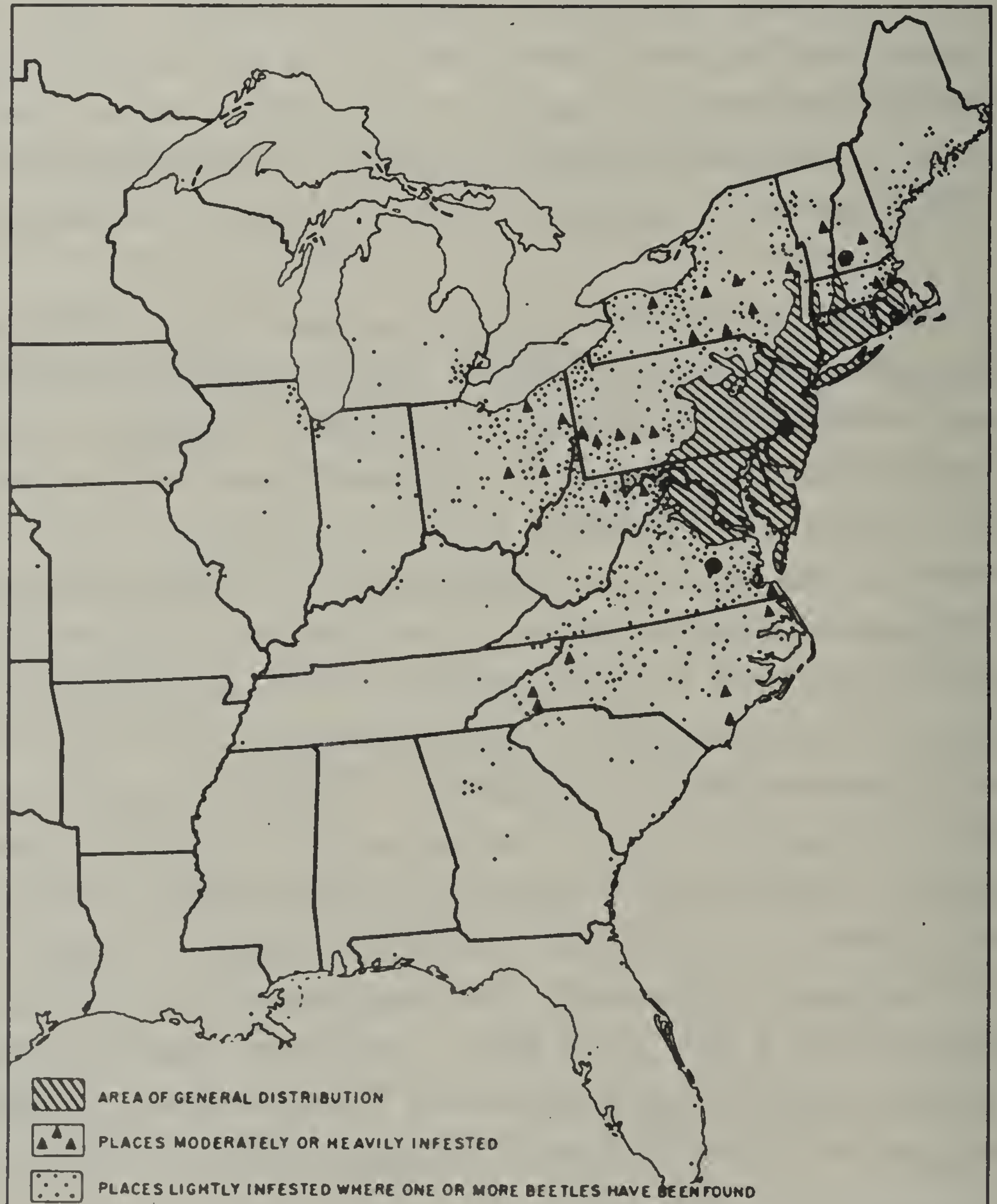

Fig. 2. Distribution of the Japanese beetle in 1950. The central large spot marks the point of introduction into the United States. The other large spots mark places where the life cycle of the insect has been studied.

the small grubs feed on the roots of grasses an other plants. They pass through three instars and when full grown are nearly 1 inch long. By fall about 93 percent will usually have reached the third instar and the others will be in the second instar. First instars are seldom found in the fall. In Figure 4 the sod has been removed to show the grubs in a feeding position. As the soil temperature drops in October, grubs move deeper and when it reaches 50° F. (10° C.) movement ceases and hibernation starts. Most grubs are then at depths of 2 to 8 inches. As the ground warms up in March, grubs move upward and feed for some time before they transform to pupae in Mayor early in June. The change to beetles starts in mid-June and these soon work their way to the surface of the ground and start to feed on favored food plants. This briefly is the seasonal cycle in the Philadelphia area where there is one brood a year (3).

A beetle colony at Keene, N.H., will serve to show the seasonal cycle at a northern location. The first beetles are usually found there about July 5 and many are still present in September or October, when they are killed by the first heavy frost. Grubs overwinter in all three instars, and there are usually more in the second instar than in either the first or the third. Many eggs may still be found in the ground when the soil becomes frozen, and these and many newly hatched grubs are killed, since they cannot endure a temperature of even 50° F. There is such a loss of eggs and small grubs in most years that probably the beetle will never be as abundant or as serious a pest in this northern area as it has been farther south. A few grubs require two years to complete their life cycle in this area, a condition common in northern Japan (4).

At points south of Philadelphia the Japanese beetle emerges earlier and the time for changing from one stage to the next is advanced. At Richmond, Va., the first beetles are often found late in May, the peak of abundance occurs about the middle of July, and few are found after early in August. No careful studies of beetle behavior have been made at points south of Richmond.

Between Keene on the north and Richmond on the south, there is a difference of 520 air miles, a difference of over 100 days in the frost-free period, and a difference of 13 Fahrenheit degrees in the mean annual temperature. There is roughly 40 days' difference in the time when the first beetles are found and, as has been pointed out, there are marked differences in the season cycle. The insect is well established at both places and may be found with gradations in the seasonal cycle throughout most of the intervening area.

Influence of weather conditions on the behavior of adult beetles. The Japanese beetle is a sun-loving insect which is most active during the warmer part of summer days. Early in the morning beetles rest quietly and feed on low-growing plants, if they feed at all. About midmorning, when the temperature approaches 70° F. (21.1° C.), they become more active and fly to taller food plants, where they feed on the upper leaves. They return to lower plants late in the afternoon. The relative humidity of the air influences beetle activity, for when it is above 50 percent beetles rest quietly and feed. On cool

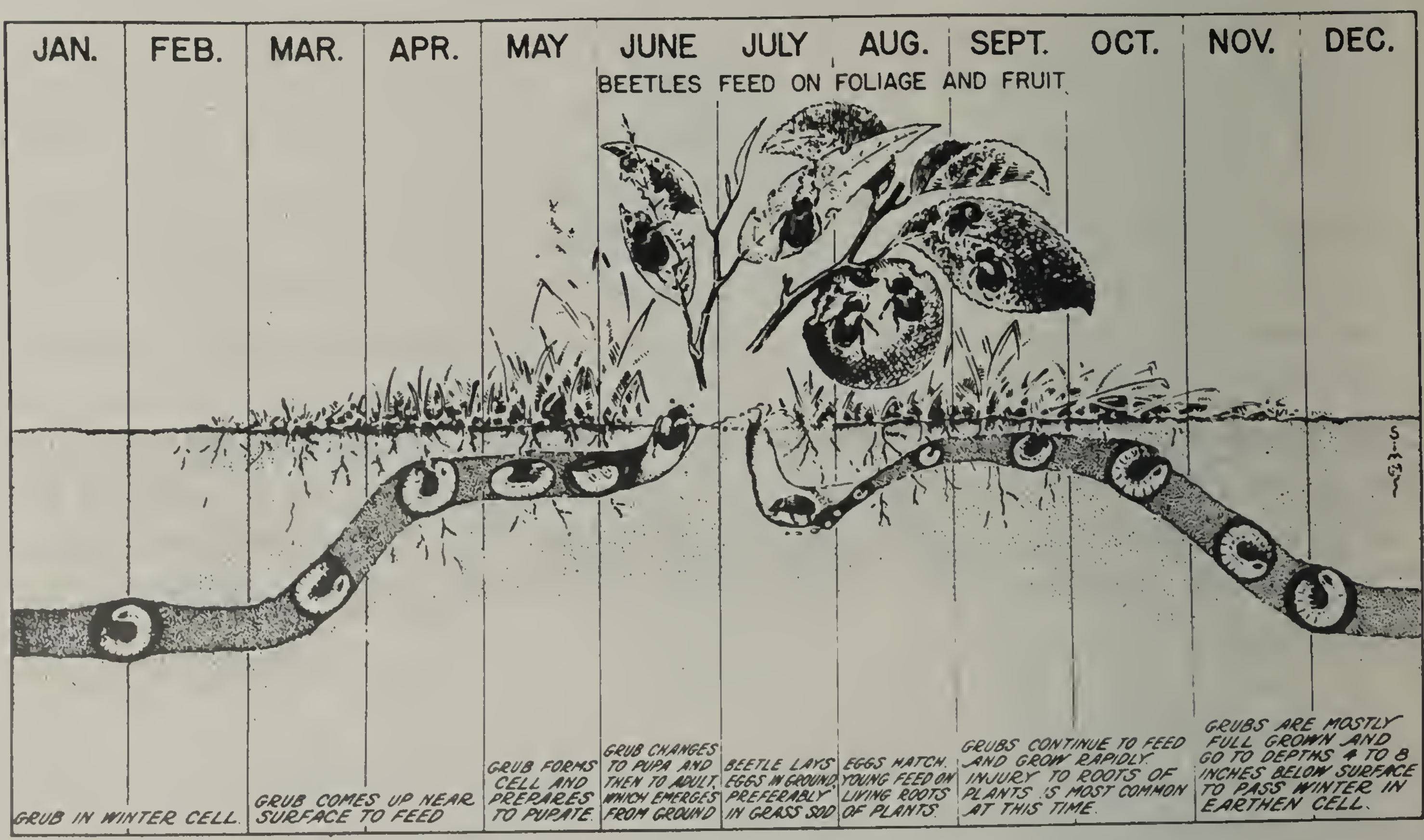

Fig. 3. Diagramatic representation of the seasonal life cycle of the Japanese beetle in the central part of the infested area in United States.

Fig. 4. Grubs of the Japanese beetle as seen in the ground after the turf has been removed.

and rainy days there is little movement. When the humidity is below 50 percent, beetles become nervously active, fly about a great deal, and change food plants often. If there is a strong wind, beetles will be carried along with it and such movements often develop into mass flights, in which beetles travel long distances. Sometimes they are carried from the land over bodies of water, where some drop and are washed up, still alive, on other shores at distances of several miles from the starting point. When attracted by the aroma of bait traps or that emanating from favored food plants, beetles usually fly against the wind.

The Japanese beetle is a gregarious insect. It gathers in numbers and feeds on certain food plants, while other plants nearby are untouched (6). On favored food plants the beetles feed heavily on the foliage and congregate on the fruit, as on the peaches shown in Figure 5. If beetles are present in great numbers there will be a noticeable buzzing sound, such as is made by a colony of bees. The leaves of most plants after being attacked by beetles have a skeletonized appearance, like those on the elm shoot in Figure 6.

The number of grubs in any location is governed by the attractiveness of that place for oviposition by the adult beetle. The moisture content of the soil influences this, for when rainfall is deficient the soil becomes so dry and hard that it is difficult for beetles to enter for egg laying. In dry years oviposition will be concentrated in low, moist places, where there will be many grubs, but only a few will be found in dry locations.

Influence of climatic factors on survival. Summer is the time when the Japanese beetle is most susceptible to unfavorable weather conditions, because there must be plenty of soil moisture if eggs are to swell and complete their embryological development (7). Newly hatched grubs cannot stand desiccation. Summer rainfall in the Philadelphia area is normally about 12 inches, but there have been years with only about half this amount over large areas and in a few places it has been as low as 2 inches. Beetle populations are always greatly reduced in summers following years with such dificiencies. The ideal condition for egg survival is a rainfall above 12 inches, for the greatest increases in beetle populations have occurred after summers with excessive rainfall. One important difference between weather conditions in Japan and the United States is in the amount of summer rainfall. At Tokyo, for example, the normal rainfall is 17.8 inches, nearly 50 percent more than at Philadelphia.

Rainfall deficiencies in the spring and fall are less important, for the stages that occur then are better able to stand drying. Grubs of all stages, except those newly hatched, have been desiccated until they lost half their original body weight, and they still lived when returned to a condition of normal moisture (8). Prepupae and pupae are able to lose 30 percent of their original weight and survive. Excess rainfall is not harmful to most beetle stages, for grubs of all sizes, as well as prepupae and pupae, have been submerged for periods ranging from a few days to several weeks by overflowing streams without suffering apparent injury. Grubs have been submerged throughout the winter in frozen cranberry bogs with little mortality. Eggs are killed by prolonged submersion.

Fig. 5. Japanese beetles feeding on the fruit and foliage of peaches.

Fig. 6. Elm shoots on which the Japanese beetle has been feeding. The skeletonized condition is typical of attacked foliage.

Beetle populations are seldom reduced by winterkilling. Soil surveys covering a 7-year period showed an average drop in the soil population of only 3 percent between November of one year and March of the next (1). There is usually a snow cover on the ground when temperatures are lowe, and this serves as an insulator, preventing the temperature of the soil from falling much below the freezing point, 32° F. (0° C.). Evidence from several sources indicates that an exposure of 3 to 4 hours at a temperature of 15° F. (−9.4° C.) is needed to kill grubs of the Japanese beetle (2). Records taken at the Japanese Beetle Laboratory show that the temperature at a 3-inch depth beneath grass sod did not fall below 21° F. (−6.1° C.) during a 20-year period, even though the air temperatures were much lower, sometimes as low as −9° F. (−22.8° C.). During an unusually cold period in the winter of 1935, recording thermometers were in use at a 3-inch depth beneath grass sod with a snow cover of 3 to 10 inches, in fallow ground with a similar snow cover, and in fallow ground with the snow removed. The minimum temperatures recorded during this cold period were 32° F. beneath grass sod, 24° F.(−4.4° C.) in fallow ground with snow, and 15° F.(−9.4° C.) in fallow ground without snow. Minimum air temperatures during this cold period of 15 days averaged 7° F. (−13.9° C.) and the lowest temperature was −9° F.(−22.8° C.). These are the temperature conditions normally found in the Philadelphia area. In the infested area to the north, winter temperatures are often much lower, but there is usually more snow and grub mortality has seldom been heavy.

Only once in the past 25 winters has there been a high winter mortality of hibernating grubs in the Philadelphia area (5). During a mild period in the winter of 1935–36 there was a heavy and continuous rain for several days and the ground became water-soaked. This condition was followed by a rapid drop in temperature that turned the rain to sleet, and the ground was coated with ice and frozen solid to a depth of several inches. The lowest temperature recorded at a 3-inch depth beneath turf was 28° F.(−2.2° C.), and yet soil surveys made early in the spring showed mortalities ranging from 50 to 100 percent by actual count of living and dead grubs. In places where there was snow instead of sleet during this period, the mortalities ranged from 1 to 10 percent. Killing of this type, which is apparently due to water and ice in contact with the bodies of the grubs, is so unusual that it may not occur again for many years.

Climatic limitations to the further spread of the Japanese beetle in the United States. Predictions as to the probable future behavior of the Japanese beetle in this country were made by Dr. HENRY FOX (2) on the basis of a comparison of the climatic conditions of the insect's native Japan with those of this country. The Japanese beetle occurs in nearly all parts of Japan, but not in any other part of Asia. Dr. FOX believed that the beetle would have difficulty in establishing itself in the colder parts of the northeastern United States, because the summers are too short and cold. Some support for this belief lies in the fact that it was impossible to find beetles in 1950 at certain northern points where they had been found eeasily in former years.

West of the Mississippi River only a few beetles have been found, and probably the insect would not thrive in most of this area because of the low summer rainfall. There is a section of the country west of the Great Lakes known as the Northern Interior, where winter temperatures are low and there is sometimes little snow. FOX believed that hibernating grubs would be killed by the low winter temperature of this area.

In this area east of the Mississippi River, the beetle should be able to spread long distances beyond the limit of the area of general distribution, before it encounters any climatic barrier to its establishment. There are places along the South Atlantic and Gulf coasts where temperatures are higher than anywhere in Japan, and the sandy soils might become so hot that the soil-inhabiting stages would be killed. There is normally little rain in this area during the winter months and the vegatation is quite different from that in the insect's present range. It is uncertain how the beetle will react to these conditions.

Present status of the beetle in the United States. The Japanese beetle has found ecological conditions in the eastern United States to its liking, and has developed into one of the most serious pests ever to enter this country. Beetles have heavily attacked many economic food plants and the grubs have destroyed large areas of turf in lawns and pastures. There is no practical way of preventing the natural dispersion of the pest around the edge of the area of general distribution. Quarantine restrictions tend to prevent the movement of beetles and grubs from infested areas to remote uninfested points. It is possible to prevent feeding on important food plants by spraying them with DDT or some other poison and, if grubs are injurious to turf, they may be destroyed by poisoning the soil. Biological control agents, such as the milky disease (Bacillus popilliae Dutky) and the spring Tiphia (*Tiphia vernalis* Roh.) may be introduced in newly infested areas. In places where these parasitic forms have become established, they are playing an important role in reducing beetle populations. It is possible to live with the Japanese beetle in the United States, but we will have to fight it when it is present in large numbers, to prevent injury to economic plants.

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DISCUSSION

(answers by Mr. Bishopp)

Mr. **Thomas**: It would seem from what Mr. BISHOPP has said, that Japanese Beetle is a great potential danger to Europe as a whole. Would it not be advisable for European Plant Protection Organisations to meet representatives of the U.S.A. to devise quarantine measures for preventing the beetle becoming established in Europe?

Mr. **Bishopp**: There is little doubt that the Japanese Beetle could establish itself in England at least in South England and in the warmer and moister parts of Europe, also that, if established, it would become a very serious pest in areas favorable to it. Every effort should be made therefore to exclude the pest. I am sure, United States authorities would extend full cooperation to European agencies in efforts prevent the introduction of this pest into Europe.

Mr. **Jepson**: Is the biological control of *Popillia* being actively proceeded with?

Mr. **Bishopp**: Yes. Much dependence is being put on biological control, especially with the use of milky disease in lawns and golf greens. Distribution of this disease on government parks and airfields is proceeding under government auspices and in cities and towns by the purchase and distribution of the disease by individuals. Parasites are being distributed by several agencies.

Mr. **Mayne**: Le Gouvernement prend-il en charge la lutte contre *Popillia japonica?*

Mr. **Bishopp**: The Federal Government is continuing enforcement of quarantine and other measures to prevent the further spread of the pest. At a recent hearing held by the Bureau of Entomology and Plant Quarantine it was shown by those testifying, that even though the pest is now widely distributed it would be economical to continue to maintain present quarantine and control efforts. The Government does not carry on extensive control operations, but gives the people information on how to combat the beetle and practice these control measures at their own expense.

Mr. **Couturier**: Dans les localités où *P. japonica* se trouve habituellement le plus nombreux, observe-t-on des variations sensibles dans l'abondance des insectes au cours des années? Où cette pullulation est-t-elle toujours très forte?

Mr. **Bishopp**: There are considerable fluctuations in the abundance of the beetle from year to year, but less than occurs in the case of many other pests. The reasons for this are somewhat indicated in Mr. HAWLEY's paper. There are fewer beetles and probably less loss in the originally infested area than during the earlier years. Probably biological control is a large factor in this decline in abundance.

DYSPESSA ULULA BKH., EIN SCHÄDLING VON ZWIEBELGEMÜSE

von
J. ROZSYPAL
Brünn, Tsjechoslowakei

Dyspessa ulula gehört zur Gruppe der mittelgrossen Schmetterlingsformen der Familie Cossidae, die im System Subordo-Frenata mit den primitiveren Familien in der Superfamilie Tineoidea vereinigt ist. In den älteren Systemen finden wir diese Art in der Gruppe der Grossschmetterlinge in der Familie Bombycidae eingereiht.

Ursprünglich, mit anderen Arten dieser Gattung in Südwestasien heimisch, ist *Dyspessa ulula* derzeit in Mittel- und Südwesteuropa als eine sehr variabele ökologische Rassen bildende Form faunistisch bekannt. Die Uebersicht der geographischen Verbreitung mancher Arten (nach Literaturangaben und Fundorten in den Sammlungen) lässt vermuten, dass die Wanderung aus der ursprünglichen Heimat Südwestasien, südwestlich über Kleinasien und den Balkan bis nach Spanien und nordwestlich über das transkaspische und transkaukasische Gebiet nach Südrussland, der Vorkaukasien und der Ukraine und in beiden erwähnten Richtungen nach Mitteleuropa erfolgte. Aehnlich liesse sich erklären das Vordringen über Syrien und Palestina nach Aegypten und angrenzenden Gebieten. Algerien, Marokko und Mauretanien besiedelten einige Arten wahrscheinlich direkt aus dem Westen entlang des Mittelmeeres und möglicherweise au. dem Umwege über Spanien. Aus Mittel- und Westeuropa sind Fundorte verzeichnet aus Deutschland, Oesterreich, Ungarn, der Schweiz, Mittelfrankreich und den Balkanländern. Es gibt auch die Möglichkeit einer passiven Ausbreitung dieser Schmetterlingsart im Stadium der im Verpuppungskokon überwinternden Raupen mit der eingeführten Handelsware (hauptsächlich Knoblauch und Zwiebeln) aus den östlichen Produktionsgebieten. Die verschiedenen ökologischen Einflüsse spiegeln sich in durch Grösse, Form, Farbenton und Flügelzeichnungen mehr oder weniger differenzierten Rassen. Eine genauere Feststellung des Verbreitungsgebietes der *Dyspessa ulula* wird erst nach eingehender Ermittlung der subspezivischen Zugehörigkeit der mediteranen Populationen möglich sein.

In der Tsjechoslowakei gehört *Dyspessa ulula* zu den bemerkenswerten Erscheinungen der Schmetterlingsfauna. Jedoch in manchen Jahren tritt die Art zahlreicher auf wie zum Beispiel in Böhmen in den Jahren 1905–35–38–50, in Mähren 1905–30–48–49, in der Slowakei 1933–38–50. Die Raupen, die sich sonst von wildwachsenden Alliumarten (so von A. flavum, A.montanum, A.vienale und wahrscheinlich auch anderen) ernähren, befallen auch Kulturen von A.sativum und A.cepa. In Osteuropa werden die Knoblauch- und Zwiebelkulturen regelmässig beschädigt. In Transkaukasien, der Ukraine und den Balkanländern ist *Dyspessa ulula* als sehr ernster Schädling

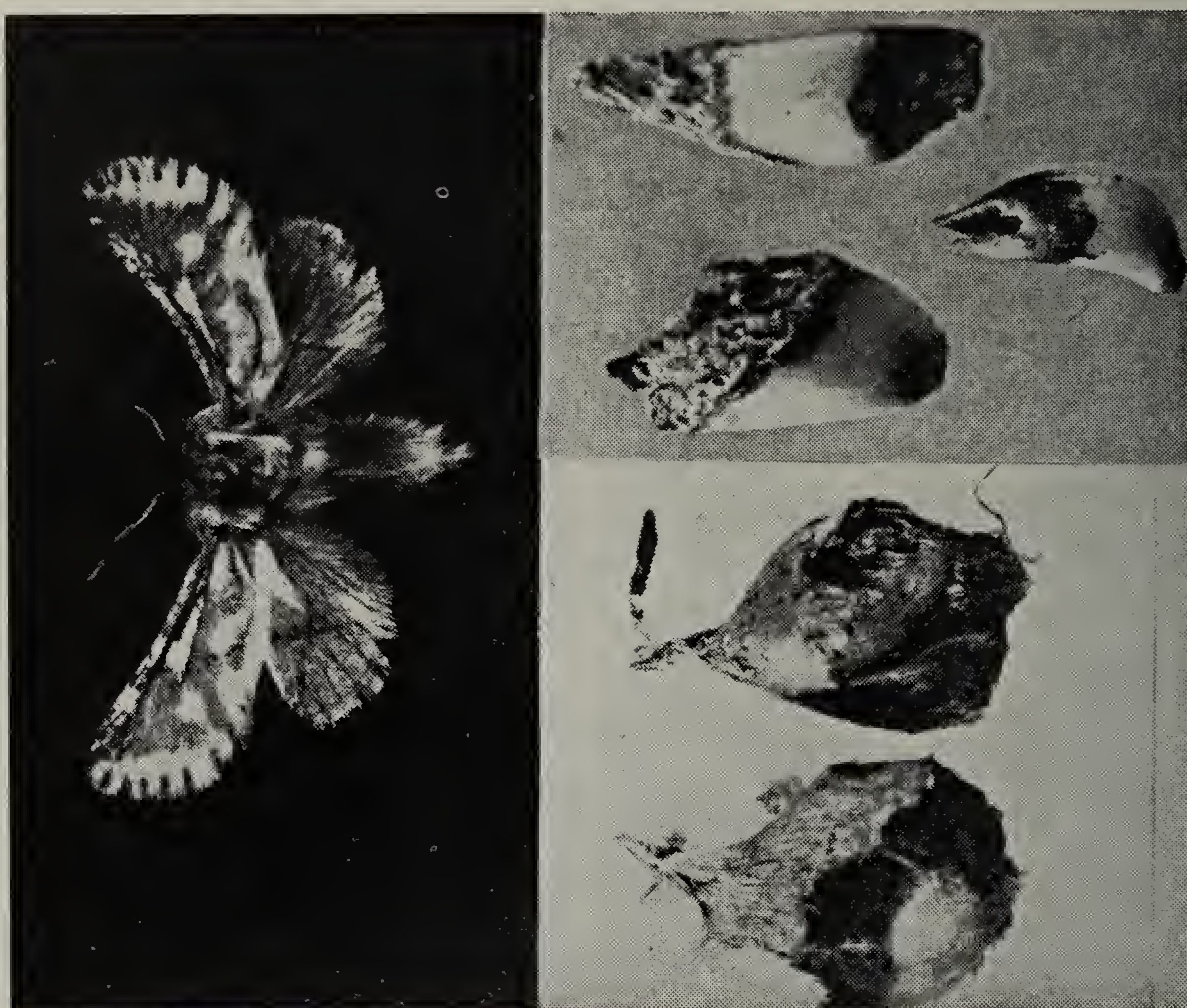
an Zwiebelgemüse gut bekannt, wie es auch die dortigen Namen des Schädlings beweisen.

Ein zahlreiches Auftreten der *Dyspessa ulula* im Jahre 1950 in Südmähren ČSR und starke Beschädigung einer 1 ha grossen Knoblauchkultur gab auch zu dieser Arbeit den Anlass. Fast ein Drittel der Pflanzen war entwertet direkt durch den Innenfrass an Knoblauchzwiebeln und indirekt durch verschiedenartige kleinere Verwundungen, welche später infolge einer sekundären Infektion durch Mikroorganismen teilweise noch vor der Ernte im Felde oder nachträglich im Lager verfaulten.

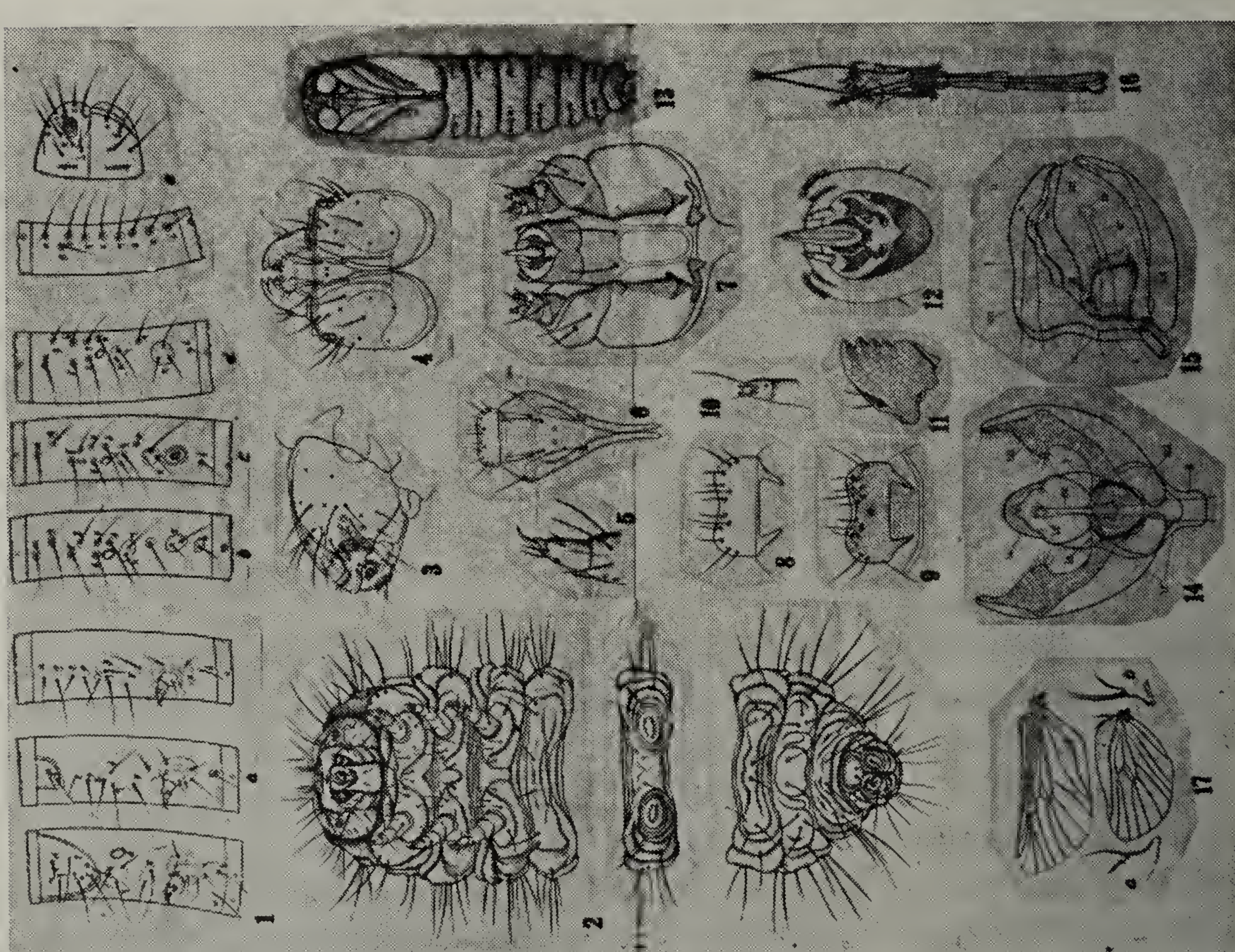
Die Bionomie des Schädlings ist in Kürze die folgende: Flug der Schmetterlinge Anfang und Mitte Juni, gewöhnlich zwischen 20 und 22 Uhr, die Männchen früher (Mitte-Ende Mai öfters zu Lichtquellen fliegend) als die Weibchen. Bald folgt die Eiablage auf basale Teile der Pflanzen. Die Produktionsfähigkeit der Weibchen ist nicht bekannt. Raupenfrass Juni–Juli–August, insgesammt ungefähr 5–6 Wochen. Die vollentwickelten Raupen verlassen die Frassstellen und verpuppen sich in einem lockeren aus weisslichen Fäden und feinen Erdteilchen gesponnenen rundlichen abgeflachten Kokon, in ähnlich geformter Puppenwiege im Boden, aber nicht selten auch in der ausgefressenen Aushöhlung der Knoblauchzwiebel, was zur Verschleppung des Schädlings mit Handelsware auf grosse Strecken beiträgt. In der zweiten kurzen Entwicklungsphase im Frühjarhr verlässt die Raupe die provisorische Unterkunft, spinnt sich in einen neuen länglichen ebenfalls locker angefertigten Kokon und verwandelt sich hier in die für die Familie Cossidae typische Puppe. Ende Mai enthalten die Puppen schon vollentwickelte Schmetterlinge, bereit zum Ausfliegen.

Bis jetzt wurde bei uns dem Schädling zu wenig Aufmerksamkeit gewidmet, um seine wirtschaftliche Bedeutung näher abschätzen zu können. Ein schwacher Befall der Kulturen kann leicht unbeachtet bleiben, da die Raupen schon ziemlich erwachsene Pflanzen befallen und der starke Frass in die Zeit der Zwiebelreife und des natürlichen ablebens der Blätter fällt. Aber auch bei der Ernte soll nicht immer die wahre Ursache der Beschädigung richtig gewertet werden und der Frass irrtümlicherweise anderen Schädlingen (zum Beispiel der viel verbreiteten Saateule, den Engerlingen, der Maulwurfsgrille und anderen) zugeschrieben werden. Auch die sekundären Fäulniserscheinungen verführen oft zur falschen Diagnose, besonders wenn der Schaden erst während der Erntezeit wahrgenommen wird und die Raupen ihre Frassstelle schon verlassen haben.

Kurze Beschreibung der Entwicklungstadien: Das Ei tönnchenförmig, rötlich, mit wahrnehmbarer feiner Oberflächenstruktur. Raupenkörper ca. 20–22 mm lang, mässig abgeplattet mit tieferer Segmentierung, dorsolateral rosa bis fleischrot, ventral gelbrötlich, spärlich mit 2–3 mm langen auf kleinen Warzen sitzenden Borstenhaaren bewachsen. Auf dem Rucken des 1. Segmentes ein starkhorniges Nackenschild und eine kleinere hornige Platte auf dem 2. Segment. Brustfüsse verhaltnissmässig schwach, hellbraun mit feiner Klaue. Abdominalfüsse mit uniserialen transversen Bandfüssen, je



Dyspessa ulula Bkh. ♂, beschädigte Knoblauchzwiebeln und einzelne Zehen.



mit 14 Höckerchen, auf oberem mit 6 oder 4, auf unterem mit 8 oder 10 Höckerchen. Das ganze Aussehen und der typische Geruch errinert an die junge Raupe von *Cossus cossus.* Kopf prognath dorsoventral abgeplattet, tief im 1. Segment eingeschoben, glänzend gelbbraun, spärlich mit feinen gelben Borstenhaaren und Poren besetzt.

Puppe sehr ähnlich der *Zeuzera pyrina,* ca 17 mm lang, glänzend gelbbraun mit für die Familie Cossidae typisch geformter Frontoclipealregion und bis auf das ventrale Mittelfeld mit gezähnten Abdominalsegmenten und Cremaster.

Imago in Grösse und Zeichnung sehr variabel, 20–25 mm Flügelbreite, Körper dicht und lang behaart. Fühler beim ♂ stärker ausgebildet, beider seitig gekämmt, typ. Lamelatae, mit feinen dichten Härchen bewachsen, beim ♀ innen stärker, aussen schwächer sägeartig; einzelne Fühlerglieder mit feinen Haarbüscheln auf den Spitzen. Grundfarbe der Vorderflügelflächen lichtbraun mit weisslicher Zeichnung. Hinterflügel etwas dunkler graubraun. Beim ♀ bilden 4 zusammengewachsene Borsten das Frenulum, beim ♂ eine einzige starke Borste.

Weitere morphologische Merkmale sind teilwese aus beigefügtem Text zu den Tafelabbildungen ersichtlich.

TEXT ZU DEN TAFELABBILDUNGEN

1. Chaetotaxie des Raupenkorpers, a-thorac.segm. 1, 2, 3, b-abd. segm. 1–2, c–3–6, d–7–8, e–9–10. 2. Die Raupe mit denselben Segmenten ventral 3–4. Chaetotaxie des Kopfes. 5. Beborstung d. Brustfüsse. 6. Clypeus 7. Maxillen, Labium ventral. 8. Labrum dor. 9. Labrum ventr. 10. Antenna. 11. Mandibula. 12. Labium. 13. Puppe. 14. Kopulationsapparat ♂ ventr. 15. Kopulationsapparat ♂ lat. 16. Kopulationsapparat ♀. 17. Vorderflügel ♂, Hinterflügel a, ♂ b, ♀.

OBSERVATIONS SUR UNE SECONDE GENERATION DE LEPTINOTARSA DECEMLINEATA SAY OBTENUE SUR SOLANUM DEMISSUM

par

M. BOCZKOWSKA

Paris, France

Summary

Solanum demissum a été reconnue comme une plante toxique pour *Leptinotarsa decemlineata.* Il a été constaté à Versailles que l'alimentation des imagos avec cette plante provoquait la dégénerescence des ovaires. Dans nos essais les larves élevées sur des plantes étiolées de Solanum demissum en automne de 1949 à Grignon ont donné des adultes. Après l'hibernation ces adultes mis sur une plante toxique de Solanum demissum var. Bergerac sous une cage au champ ont déposé quelques pontes faibles en août. Les larves issues de ces pontes se sont developpées normalement avec une alimentation constituée par des feuilles provenant du même pied (par rapport aux témoins sur Ackersegen).

SUR L'IMPORTANCE DE LA MICROFAUNE DU SOL EN AGROBIOLOGIE

par
C. DELAMARE DEBOUTTEVILLE
Banyuls-sur-Mer, France

La Zoologie, et tout particulièrement l'Entomologie, peuvent apporter une contribution primordiale à l'urgent problème de la protection et de la régénération des sols.

La microfaune, dont l'immense majorité est constituée par les Arthropodes, joue un rôle de tout premier plan dans la „vie du sol". Il suffit, pour s'en rendre compte, d'observer un humus forestier avec son incroyable grouillement d'individus.

Cinq travaux récents ayant traité de la microfaune du sol WEIS-FOCH (1948), OVERGAARD NIELSEN (1949), KUHNELT (1950), FRANZ (1950) et DELAMARE DEBOUTTEVILLE (1950), je me contenterai d'insister sur l'intérêt pratique et théorique que pourront avoir des recherches de ce type dans une proche avénir.

On ne relève, dans la bibliographie, que quelques centaines d'ouvrages traitant de la vie dans le sol. Encore la plupart d'entre eux traitent-ils de points de detail plus ou moins éloignés du problème central qu'est celui de l'équilibre du sol vivant et de son évolution.

Le fait est d'autant plus troublant que le sol est non seulement le milieu le plus uniformément réparti dans l'espace et le plus constant dans le temps, mais encore la seule source des aliments.

L'épuisement et la disparition des sols cultivables étant une source d'inquiétude justifiée, leur régénération, leur amélioration constituent un problème important posé à nos générations.

Sans insister sur l'importance numérique de la microfaune du sol, au sujet de laquelle on trouvera de nombreux renseignements dans les cinq travaux précités, je rappelerai que le nombre total d'individus semble être un excellent indicateur des possibilités évolutives d'un sol.

Si nous considèrons un milieu extrême, trop original, à microclimat excessif, nous constatons que la flore sera très activement sélectionnée, quelques espèces arrivant seules à s'implanter et à se maintenir, le triage écologique étant particulièrement violent. Qu'il s'agisse du sol des schörres à Spartina ou de celui de certaines savanes africaines, nous observons dans ces formations un grande déficience de la vie animale, la microfaune étant toujours peu nombreuse.

De tels milieux ont, en général, une „vocation" beaucoup trop particulière pour pouvoir être changés rapidement et efficacement, donc durablement, par des procédés culturaux.

Si nous comparons de telles formations à des formations naturelles équivalentes mais tempérées, c'est-à-dire à microclimat non extrême et à caracté-

ristiques physico-chimiques moins accentuées, nous constatons que, même si le couvert végétal est relativement peu diversifié en raison des inégalités inévitables qui régnent en surface, la microfaune est, au contraire, toujours abondante et assez variée.

Qu'il suffise, pour s'en rendre compte de comparer la répartition quantitative de la microfaune en fonction de la profondeur dans une savane à Graminées aux environs de Bouaké (Côte d'Ivoire) à celle d'un podzol dénudé breton. Ce dernier apparait comme un milieu bien vivant quoique non cultivé; ses vocations sont multiples. Son exploitation est affaire d'astuce agronomique guidée par les besoins (fig. 1).

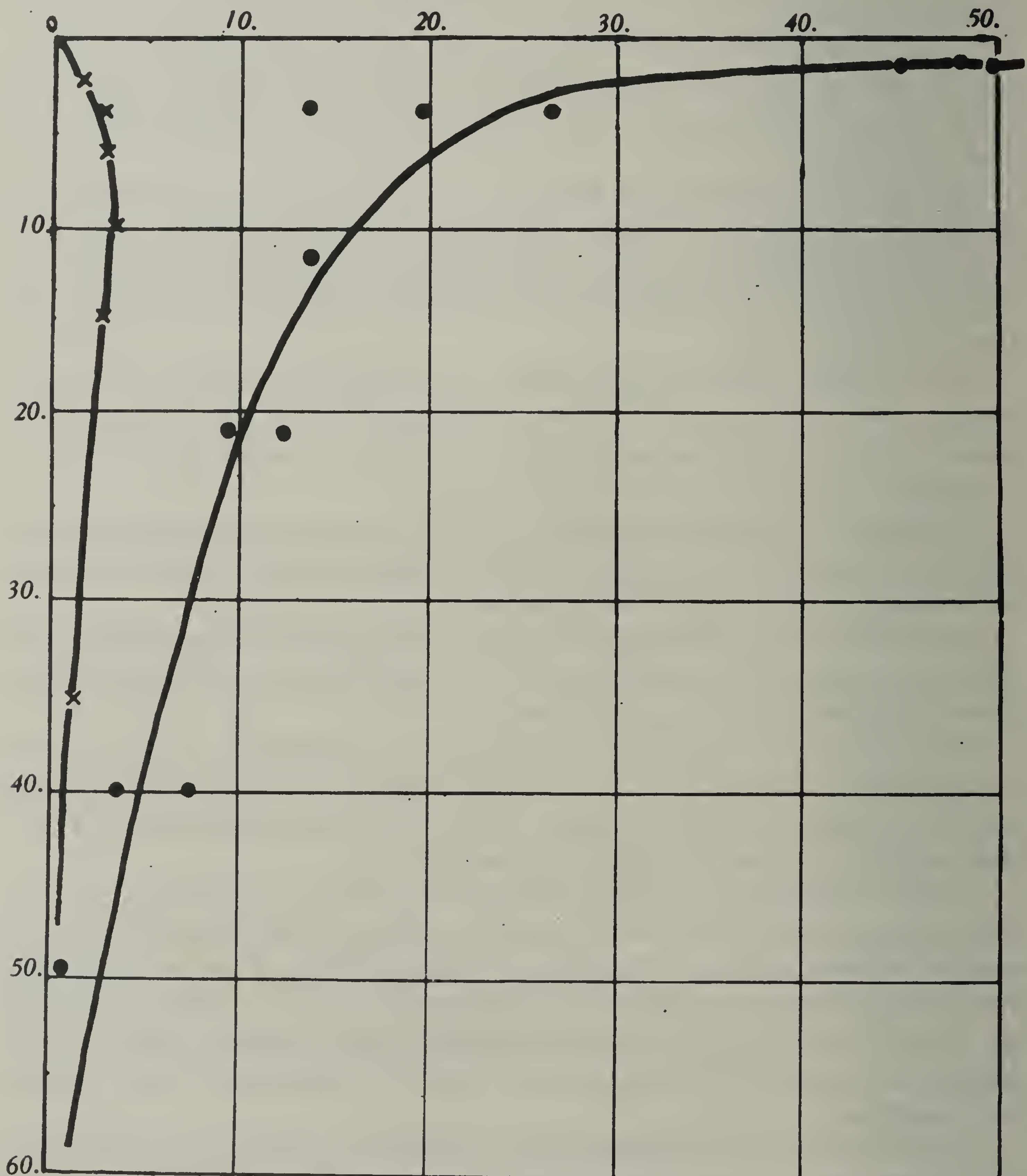


Fig. 1 — Importance relative de la microfaune en fonction de la profondeur dans deux biotopes non forestiers. 10, Savane à Bouaké (Côte d'Ivoire). Podzol dénudé breton (Finistère, France). — En abscisses le nombre d'individus pour 100 cc., en Ordonnées la profondeur en cm.

En fait, il semble que l'abondance de la microfaune, infiniment plus facile à percevoir qu'il n'est aisé de mettre en évidence la microflore, soit un excellent indicateur de l'état vital d'un sol.

En eux-mêmes les renseignements quantitatifs ne peuvent cependant pas rendre de grands services en agrobiologie. Il n'en est plus de même en ce qui concerne les renseignements qualitatifs dont l'obtention est, il est vrai, infiniment plus compliquée. Une analyse microfaunistique qualitative exige la collaboration de nombreux zoologistes spécialistes et est, de ce fait, difficile à mener à bien. L'on peut cependant obtenir des renseignements utiles en n'effectuant qu'une analyse fragmentaire, réduite à un seul groupe (GISIN 1947, DELAMARE 1950) ce qui simplifie considérablement le problème sous l'angle pratique.

Tous les animaux qui participent au peuplement d'un sol donné ont des physiologies différentes et réagiront donc différemment à l'action de tel ou tel facteur du milieu. Par ailleurs la présence, dans un milieu donné, des organismes vivants supérieurs que sont les Arthropodes, est régie par la loi écologique du tout ou rien, à savoir que la valeur excessive de tel ou tel facteur élimine complétement, par mort, tous les individus des espèces qui ne peuvent pas supporter cette valeur, limite pour elles. On constatera, par exemple, une grande différence entre les peuplements des sols *toujours* humides et ceux des sols *parfois* secs.

De plus, les organismes de la microfaune, êtres vivants, ne réagissent qu'à la résultante des actions combinées de la totalité des facteurs du milieu.

Sous l'angle analytique, l'étude qualitative permettra donc de dresser, par une table des présences et des absences, une échelle correspondant à chaque facteur pour peu que l'on connaisse les maxima et les minima de chacune des espèces composantes par rapport à ce facteur.

Sous l'angle synthétique, elle permettra de caractériser le milieu par une certaine „ambiance" qui est précisément celle dont s'accomodent ensemble les espèces composant le peuplement.

Ces ambiances, caractérisées par des communautés animales, seront définies par celles-ci beaucoup plus que dans l'immédiat. Le loi du tout ou rien intervient en effet pour faire de la microfaune non seulement le reflet des conditions actuelles, mais encore pour porter témoignage de ce qui peut survivre autravers des modifications cycliques ou irrégulièrement accidentelles du milieu.

La localisation des associations animales apporte sur l'évolution du sol des renseignements d'ordre dynamique dont l'intérêt est grand. Il serait très utile, pour mettre au point les méthodes, de commencer l'étude de quelques stations expérimentales en dressant un inventaire aussi précis que possible.

Ces recherches auraient une grande valeur pratique et permettraient un jour d'aller infiniment plus loin que ne peuvent nous conduire les résultats des analyses physico-chimiques qui se limitent à la catégorisation de phénomènes fixés, jeux de l'activité conjointe du matériel minéral, du climat et des êtres vivants.

En se servant de la microfaune pour caractériser les sols on obtiendrait des renseignements d'une haute valeur, car la vie réagit d'une façon beaucoup plus subtile que les corps bruts et permet de déceler des phénomènes beaucoup plus complexes et beaucoup plus tenus.

Tandis que les recherches sur la microbiologie du sol ont été relativement nombreuses (WINOGRADSKY, WAKSMAN etc.....), les recherches sur la microfaune, nous l'avons vu, en sont encore à leurs débuts. On ne connait pratiquement rien du rôle des Vers et des Arthropodes dans le sol, bien que leur importance dans l'instauration d'un sol ait été mise en évidence en ce qui concerne la naissance d'un sol coprogène (FALGER 1922) et que le parallélisme entre l'épuisement d'une formation et la diminution de la microfaune soit un fait patent (DELAMARE 1950).

L'effet antagoniste des Protozoaires, des Nématodes (OVERGAARD) et des Collemboles (DELAMARE) sur les bactéries a été mis en évidence, mais nos connaissances sont nulles en ce qui concerne l'importance de chaque espèce dans l'élaboration de l'humus. Tout un programme de recherches doit être élaboré. Il importerait de connaitre exactement le régime alimentaire de chaque espèce et les modifications physico-chimiques que ces espèces font subir à un volume donné de terre en un temps donné, de savoir comment se conjuguent les activités de plusieurs espèces élevées conjointement, de savoir quelle part la microfaune joue dans les divers cycles d'éléments dont le déroulement est essentiellement assumé par les bactéries. La solution de ces diverses questions présenterait le plus grand intérêt pour les pédologues et, d'autre part, la valeur de la microfaune en tant qu'indicateur en serait renforcée.

La microfaune du sol est également intéressante à un autre point de vue. Il est évident que, dans un sol donné, l'on ne peut rencontrer que les espèces qui ont eu l'occasion, au cours des remaniements historiques, de gagner la région où existe ce sol, le transport passif étant impossible à invoquer en ce qui concerne la presque totalité des lignées édaphiques (tout particulièrement dans le cas des Collemboles).

Les peuplements des formations actuelles ont été mis en place au cours des remaniements géographiques et climatiques des temps passés. Ils sont le fruit de l'histoire. Il en résulte qu'il n'y a aucune raison de penser que les pueplements en place actuellement soient les plus adéquats à remplir les fonctions qui leur sont imparties dans le métabolisme d'un sol. Il y a, au contraire, tout lieu de penser que lorsque les recherches sur la microfaune auront fait de grands progrès, il sera possible de sélectionner des microfaunes particulièrement aptes à assumer le bon rendement d'un sol donné. L'implantation de ces microfaunes sélectionnées ne devrait pas être difficile si l'on songe à l'habituelle pullulation des espèces allochtones implantées dans une faune harmonique. En ce qui concerne les Collemboles il semble que l'indigénation ne soit pas impossible à obtenir (*Paranurophorus simplex* Denis, du Yunnan, vit fort bien dans les serres non chauffées du Muséum de Paris, etc....).

Quand le rôle des espèces de la microfaune sera mieux connu un nouveau champ de recherches, particulièrement productif, sera ouvert.

Pour atteindre ces objectifs éloignés il serait nécessaire que de nombreuses équipes travaillent en commun sur le plan international. Il y faudrait la collaboration de systématiciens pour dresser l'inventaire, de physiologistes, d'écologistes, de microbiologistes, de botanistes et de pédologues qui ne peuvent se passer les uns des autres.

Les premières recherches devraient chercher à dégager les différences existant entre des formations aussi variées que possible depuis l'équateur jusqu'au Nord de l'Europe (les territoires de l'Union Française et de la Métropole se prêteraient particulièrement bien à ce type de travail).

Il conviendrait d'étudier au laboratoire les caractéristiques physiologiques des espèces caractéristiques et dominantes. La mise au point des méthodes d'analyse biocénotique pourrait être effectuée à la lumière des données recueillies en des régions très différentes.

De nombreux esprits ont déjà saisi l'urgence de ces recherches et l'on commence, en certains pays, à envisager d'aider ceux qui se préoccupent de la vie et de la santé du sol.

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DIE EINBÜRGERUNG DES SPEISEBOHNENKÄFERS ALS FREILANDSCHÄDLING IN DEUTSCHLAND

von

ALBRECHT HASE

Berlin-Dahlem, Deutschland

Auf Grund vorliegender Beobachtungen hat sich ergeben, dass der Speisebohnenkäfer *Acanthoscelides obtectus* als voll eingebürgerter Freilandschädling jetzt betrachtet werden muss. Für den Bohnenanbau ist diese Tatsache von besonderer Bedeutung, da der Befall im Freien in den letzten Jahren starke Schäden und auch Totalausfälle in der Bohnenernte bewirkte.

Vor etwa 30 Jahren ist *Acanthoscelides* in Deutschland eingeschleppt worden u. anfänglich nur als Speicherschädling aufgetreten. In den letzten 10 Jahren mehrten sich die Fälle des Auftretens als Freilandschädling, auch in Mitteldeutschland. Feldbeobachtungen waren unbedingt erforderlich. Die bisher vorliegenden Ergebnisse der Züchtung in Laboratorien mussten als nicht mehr zutreffend gewertet werden. Auf dem Versuchsgelände der Biolog. Zentralanstalt, Berlin-Dahlem, wurden Mitte Mai 1950 an 40 Stangen (je 10 in d.Reihe) 150 Pflanzen (Phaseolus multiflorus, sog. Feuerbohne) ausgesetzt u. Buschbohnen-Kulturen (Sorte Saxa) angelegt. Die Ernte am 29. Aug. 1950 der Stangenbohnen ergab 4966 Samen. Das käferdicht aufbewahrte Saatgut ergab bis 10. Nov. 1950 – 703 Käfer, die sich auf den Herkunftspflanzen wie folgt verteilen.

Vertikale Verteilung von Samen und Käferbefall auf alle Stangenbohnen.

Höhe über d.Erdboden	Samenzahl in % der Gesamtzahl	Käferzahl in % der Gesamtzahl
unter 1 m	38	92
1 – 2 m	36	6
über 2 m	26	2
	100 % (4966 Stück)	100 % (703 Stück)

Die Tabelle zeigt deutlich, dass der Speisebohnenkäfer die Bodennahen Hülsen mit Befalll bevorzugt, wobei auf den besonnten Südseiten der Befall dreimal stärker war als auf den beschatteten Nordseiten. Die unter 1 m Bodenhöhe geernteten Bohnen sind als Saatgut kaum verwendbar, da sie 92% des Gesamtbefalles ausmachen. Keimversuche mit Buschbohnenkernen ergaben auch schon bei 1 oder 2 Schlupflöchern verminderte Keimfähigkeit von 25% u. 45%. An Buschbohnen 30 – 40 cm Bodenhöhe, war nach den hiesigen Beobachtungen 1950 der Befall viel stärker als an den Stangenbohnen.

Die Ernte war teilweise weder als Saatgut noch zur Ernährung brauchbar. Im Sommer 1950 wurde *Acanthoscelides* an den Blüten der Bohnen festgestellt u. zwar an den Kelch-Einbruchstellen der Hummeln, die auf diese Weise bekanntlich den Nektar erbeuten. Die Käfer nahmen offenkundlich den Blütennektar ebenfalls als Nahrung.

DISCUSSION

Mr. van den Bruel: 1. J'ai observé également *A.obtectus* en Belgique, en 1943 et 1944. Sur la base des données de ZACHER, l'insecte ne pourrait pas se multiplier en plain air en Belgique. Or, j'ai pu constater qu'en Belgique l'insecte contamine les haricots sur les champs, comme en Amérique. 2. En Belgique, l'insecte est capable de passer l'hiver sous forme de larva I, dans les haricots. Je n'ai pu vérifier les températures pendant la période d'observation, en raison des conditions de guerre. J'ai pu toutefois maintenir pendant tout l'hiver 1944–1945, qui fût très rigoureux, des haricots contaminés à l'extérieur, sous un simple couvert, largement exposés aux longues gelées. Ces haricots ont fourni des adultes au printemps. 3. Je n'ai pas observé l'alimentation des adultes sur les fleurs. Cependant, l'adulte fait beaucoup d'entailles dans les gousses de haricot mures. Un grand nombre de celles – ci ne sont pas utilisées pour la ponte.

Mr. Hase: Die Ausführungen bestätigen im Wesentlichen die Befunde in Berlin–Dahlem.

Mr. Rivnay: Mr. HASE gave interesting observations regarding the extent of infestation at various heights. Has he also carried out measurements of the microclimate at these various heights and what could be the reason for such differences of infestation?

Mr. Hase: Exakte mikroklimatische Messungen sind nicht durchgeführt worden, aber für das nächste Jahr geplant.

Mr. Horber: Im schweizerischen Mittelland konnte während und nach den zweiten Weltkrieg ebenfalls eine starke Zunahme der Schäden des Speisebohnenkäfers beobachtet werden. Die längst vermutete Vermehrung des Schädlings im Freiland, wodurch dieser vom Lagerschädling zum Feldschädling geworden ist, konnten wir durch eigene Untersuchungen in den Jahren 1947 – 1949 an der Versuchsanstalt Zürich – Oerlikon und einigen andern Orten im Mittelland und Jura, also nordlich der Alpen, bestätigen. Die vom Referenten angeschnittene Frage, wieso die südlich exponierten Stangenbohnen mehr befallen werden als die beschatteten, können wir wie folgt beantworten: Die Käfer belegen nur reife oder sich in der Reife befindlichen Hülsen. In unseren Feldversuchen wurden die frühreifen Sorten stärker befallen als die späten. Da die besser besonnten Pflanzen früher reife Schoten aufweisen, werden diese häufiger aufgesucht und stärker mit Eiern belegt. Wenn für die Käfer keine Möglichkeit besteht, frühe Sorten auszuwählen werden unter günstigen Bedingungen für die Eiablage auch die späteren Sorten stark befallen.

Die Bekämpfung des Bohnenkäfers am Lager kann unter anderem auch erfolgreich durchgeführt werden, indem sofort nach Einlieferung der Bohnen dieselben enthülst und mit Hilfe Hexachlorcyclohexan - haltiger Rauchtabletten ausgeräuchert werden. Die Bekämpfung des Schädlings im Freiland ist möglich mit zweimaliger Behandlung der Pflanzen mit D.D.T. - oder Hexa - haltiger Spritz- oder Stäubemittel kurz vor und während der Reife der Hülsen. Es fehlen uns vorläufig noch genaue Beobachtungen darüber, was der Speisebohnenkäfer zwischen Überwinterung und Eiablage treibt.

HYPHANTRIA CUNEA DRURY, UN NOUVEAU PROBLEME D'IMPORTANCE INTERNATIONALE EN EUROPE

par
Guido NONVEILLER
Zemun, Yougoslavie

SURANY annonca au Congrès de Stockholm la présence d'un nouvel ennemi des arbres fruitiers et forestiers en Europe. Il s'agit de *Hyphantria cunea* Drury, provenant de l'Amérique du Nord et appelé par les Américaines „Fall webworm". A peu près à la même époque parût une autre communication du même auteur dans les „Pflanzenschutzberichte" de Vienne. Dans ces deux articles SURANY nous fournit des précisions sur la découverte de ce papillon en Hongrie, sur son extension ultérieur dans le pays, sur les plantes très nombreuses dont se nourrit la chenille, sur les dégâts commis, les parasites constatés et les moyens de lutte qu'on peut employer pour les combattre. Il en résulte, qu'à partir de 1943, date à laquelle les chenilles furent pour la première fois remarquées en masses, cet insect se repandit rapidement à travers le territoire hongrois pour arriver en 1947 aux frontières yougoslaves et tchécoslovaques ainsi qu'aux proximités de la frontière autrichienne, c'est-à-dire qu'il occupa presque toute la Hongrie dans le laps de temps relativement court de 5 ans.

En juillet dernier, lors d'une tournée à travers la Vojvodina, région avoisinante la Hongrie, j'ai pu constater la présence de *Hyphantria cunea* Dr. en Yougoslavie. En août j'ai fait une communication sur cette decouverte dans un journal agricole yougoslave et au début de cette année j'ai publié sur le même sujet une note avec résumé en français dans le No 3 de la revue „Zastita Bilja" (Plant Protection) qui est éditée par l'Institut que je dirige à Zemun.

Je ne répeterai pas ici ce qui a été dit dans les notes mentionnées. Je voudrais seulement vous rappeler que j'y communiquais, entre autre choses, que d'après les renseignements qu'on a pu réunir, *Hyphantria cunea* Dr. est passé en territoire yougoslave déjà en 1948 et qu'il s'est répandu rapidement vers le sud pour arriver après trois ans jusqu'aux proximités de Novi Sad, c'est-à-dire qu'il a couvert dans cette une région qui comprend entre la frontière du pays, au nord, et sa limite sud 100 km en ligne aérienne. Depuis, ce ravageur a fait de nouveaux progrès dans la Vojvodina qu'on peut considérer aujourd'hui pratiquement complètement infestée d'autres foyers, peu nombreux pour le moment ont été constatés en Croatie en differents points le long de la frontière yougoslavo-hongroise.

Je profite de l'occasion qui se présente ici par la réunion de tant de collègues éminants pour souligner toute l'importance que prendra à mon avis un jour ou l'autre *Hyphantria cunea* Dr. pour la plupart des pays européens.

Nous nous trouvons sans aucune doute au début d'une de ces luttes

longues et complexes dans lesquelles se sont vues impliqués à de maintes réprises déjà l'Europe et l'Amérique, pour ne citer que ces deux continents à l'agriculture très developpée.

L'expérience acquise en Europe dans des cas semblables – je vous rappèlerai simplement celui du puceron lanigère, du Phylloxera, du Doryphore, du Pou de San José – démontre, tout d'abord, que même quand il s'agissait d'espèces relativement bien connues dans leur pays d'origine, et ce n'était pas toujours le cas, il a fallu en Europe non seulement vérifier les connaissences qu'on en avait, mais plus souvent encore entreprendre l'étude approfondie de la biologie, de l'écologie, des parasites, des moyens de lutte, etc., surtout parce que les conditions de la nouvelle ambience diffèrent en règle beaucoup de celles qu'on connait de l'aire d'extension primaire de l'espèce en cause.

Ensuite, si l'on commence tôt l'étude du nouveau ravageur, on arrivera, évidemment, plus vite à des résultats qui faciliteront le travail entrepris pour enrayer le plus possible sa progression à travers les pays et pour diminuer les dégâts qu'il commet aux cultures. Enfin, dans presque tous les cas, les circonstances même ont obligés les pays intéressés d'arriver sous une forme ou une autre à une collaboration, même si l'on ne l'avait pas entrevue ou désirée au début.

Je crois qu'il est utile, je dirais même indispensable de profiter de cette expérience faite jusqu'aujourd'hui en Europe.

Hyphantria cunea Dr. représente un sujet tout-à-fait dans cet ordre d'idée. Ses chenilles attaquent les feuilles d'un grand nombre d'arbres forestiers et fruitiers et peuvent aussi se nourrir d'autres plantes spontanées ou cultivées; la femelle est très féconde puisqu'elle pond en moyenne 600 à 800 oeufs et dans certains cas plus d'un millier; au cours d'une année nous avons deux générations et, parfois, le début d'une troisième qui, même si elle n'arrive pas au terme de son développement peut ajouter des dégâts considérables aux deux défeuillages qui ont eu lieu antérieurement au cas d'une attaque massive des chenilles et qui auront des conséquences néfastes pour les arbres attaqués; à cause de la vie cachée que mène un certain temps la chenille dans son nid, où elle se trouve à l'abris de l'action directes des insecticides employés pour la combattre et aussi en raison d'une certaine résistance qu'elle montre plus tard envers quelques uns des insecticides couramment employés aujourd'hui, la lutte chimique n'est pas facile à mener; la lutte par des procédés mécaniques – tels qu'enlèvement des nids – est difficile à organiser sur une grande echelle et à exécuter aux moments propices; la lutte biologique, très promettante peut-être, ne pourrait pas être envisagé qu'après étude approfondie de nombreux problèmes; l'extension du ravageur, enfin, a pris dès son apparition en Europe des proportions considérables – voilà assez des points pour susciter notre inquiétude.

Même les pays se trouvant assez loin de l'aire d'infestation actuelle, ne sont pas à l'abris de tout risque, puisque des pupes, des chenilles prêtes à se nymphoser ou bien des oeufs accidentellement deposés quelques part

pourraient être transportés dans d'autres pays par le commerce des produits agricoles, du bois peut-être, etc.

Il s'agit, donc, dans le cas de *Hyphantria cunea* Dr. d'entreprendre dès le début non seulement une action organisée pour combattre cet insecte par les moyens connus actuellement partout où il a été constaté, mais aussi d'envisager la collaboration internationale sur le plan scientifique afin de développer les études des divers problèmes posés par son apparition en Europe et les conséquences qui en résultent.

Ces études devront être faites, évidemment, là où se trouve l'insecte, où il abonde et où l'on peut faire des élévages sans craindre d'ajouter des risques à son extension territoriale.

Nous avons déjà entrepris l'étude de certains aspects de ce problème et commencé quelques expériences. Les entomologistes de la Station des recherches agricoles à Novi Sad s'occupent depuis l'année passée de la biologie et des moyens de lutte. L'Institut pour la protection des plantes de Zemun vient d'établir cette année un laboratoire de campagne pour étudier les parasites relativement assez nombreux qui ont été constatés déjà sur les chenilles et les pupes de *Hyphantria cunea* Dr.

Le début est donc fait. Mais nous croyons qu'il serait utile de poursuivre dans un cadre international les expériences commencées. En liaison avec les organismes européens intéresses on pourrait établir un programme d'étude élargi et plus complet. Les autorités compétentes yougoslaves, consultées sur ce point, se sont déclarées prêtes à subventionner autant que possible le travail dans le laboratoire déjà établi qui pourrait devenir ainsi un Laboratoire internationale pour l'étude de *Hyphantria cunea* Dr. Dans ce laboratoire le travail serait non seulement par les techniciens yougoslaves, mais il serait ouvert à tous ceux qui après entente préalable sur le programme à suivre désireraient étudier sur place un problème déterminé et qui pourraient être envoyés par un service pour la protection des végétaux, une station de recherches, une université ou une organisation internationale.

Le problème financier, toujours très ennuyeux, surtout quand il s'agit de dévises, pourrait être résolu de telle manière que le service ou la station qui voudrait envoyer un de ses specialistes au laboratoire, se déclarerait prête à recevoir chez elle, sur une base de reciprocité, un spécialiste yougoslave.

DISCUSSION

Mr. **Couturier**: A quel stade hiberne *Hyphantria cunea?*

Mr. **Nonveiller**: Comme pupe.

SECTION IX

FOREST ENTOMOLOGY

ÜBER ÄNDERUNGEN DER PHYSIOLOGISCHEN LEISTUNGEN VON IPS TYPOGRAPHUS L. BEI EINER UNGESTÖRT ABLAUFENDEN MASSENVERMEHRUNG

von

Siegfried BOMBOSCH

Frankfurt am Main, Deutschland

Die Untersuchungen von MORS über gradationsbedingte Veränderungen der physiologischen Leistungen von *Lymantria monacha* L. waren Veranlassung 1946 und 1947 unter dem Protektorat von Forstmeister Dr. WELLENSTEIN gleichsinnige Untersuchungen bei einer ungestörten Massenvermehrung von *Ips typographus* L. durchzufuhren. Das Versuchsgebiet befand sich im Nord-Schwarzwald in einer Höhenlage von 750-950 m. In den gleichaltrigen und gleichaufgebauten rd. 110 jähr. Fichtenbeständen hatte sich der Buchdrucker von 1944 bis 1946 ungestört vermehrt. 1947 setzte nach abgeschlossenem Anflug der ersten Generation eine Grossbekämpfung ein, jedoch wurde die Aufarbeitung interessanter Schadstellen bis zum Herbst zurückgestellt. Fusionen einzelner Käfernester waren bis zum Hochsommer 1947 nicht erfolgt, so dass die Schäden bis dahin jeweils durch einzelne Populationen verursacht wurden.

Für die Auswahl gerade dieses Gebietes war der Verlauf der Gradation entscheidend gewesen. – Die ersten Schäden im stehenden Holz wurden 1944 beobachtet. Insgesamt zählte man damals 12 getrennte Befallsherde. 1945 vermehrte sich ihre Zahl um 16 weitere Schadstellen und 1946 kamen erneut 22 hinzu. Bis zum Herbst 1946 war bei einfacher Generationsfolge in allen drei Jahren eine ständige Zunahme neu entstandener Schadstellen zu beobachten. Als Ursache für ihre Entstehung liessen sich bis dahin fast ausnahmslos Windwürfe, Zopfstücke oder einzelne abgestorbene Stämme nachweisen. Das Jahr 1947 rief mit seiner trockenen und heissen Witterung erstmalig eine doppelte Generation hervor. Die Vermehrung der Schadstellen in der ersten Generation zeigte jedoch überraschenderweise eine rückläufige Bewegung. Nur 18 neue Befallsherde wurden gezählt, von denen wiederum nur 2 autochthonen Ursprungs waren, während die übrigen 16 in mehr oder weniger weiter Entfernung von grösseren Befallsherden in Beständen ohne sichtbare Schädigung auftraten.

Auch die Ausbreitungsenergie einzelner Befallsherde, gemessen an der Zahl der befallenen Stämme, zeigte in gleichartigen Beständen erhebliche Unterschiede. So wurden beispielsweise am Sommerhang Befallsnester mit einem Ausbreitungsfaktor von 0.33, am Winterhang dagegen solche mit 1.22 und umgekehrt gefunden. Die Einordnung der verschiedenen Schadstellen nach ihrem jeweiligen Alter brachte bei zahlreichen Befallsherden im stehenden Holz in das Durcheinander der verschiedenen Vermehrungsfaktoren häufig ein klares Bild. *Es zeigte sich hier, dass der Ausbreitungsfaktor un-*

abhängig vom Standort mit zunehmendem Alter erheblich nachlässt. Er betrug im ersten Jahr nach dem Sprung ins stehende Holz bis zu 8.66; schon im nächsten Jahr war er bei 1, also Stillstand, und sank im folgenden Jahr bis in die Nähe des Nullpunktes ab. Eine ähnliche Beobachtung konnte auch in Gebieten mit gleichartiger Bekämpfung gemacht werden. Die Vermehrungszahl war hier für 2jähr. Befallsherde 0.44, fur 3jähr. 0.12.

Für die weiteren Untersuchungen wurden nur autochthone Schadstellen ausgewählt, die den oben geschilderten Verlauf genommen hatten. In diesen wurde geprüft, ob sich das Nachlassen der Schäden auch in einer Minderung der physiologischen Leistungen der Käfer widerspiegelte. Da die Brutbilder bekanntlich sehr lange erhalten bleiben, erschien es ratsam, die Eisterblichkeit und die Eizahl je Muttergang näher zu prüfen.

Methodik

Je nach Grösse des Befallsherdes wurden die zu untersuchenden Stämme entweder gleichmässig über die Fläche verteilt oder als Stammreihen durch die Schadstellen gelegt. Je Stamm wurden 2-3 Rundproben von 30-40 cm Breite entnommen. Daraufhin wurden die Larvengänge je Muttergang gezählt und durch Freischneiden die Zahl der Eigruben ermittelt. Die Differenz ergab die Eisterblichkeit. Die Besiedlungsdichte wurde durch Auszählen der Muttergänge je Rundprobe festgestellt. Zwei angeschnittene Muttergänge zählten als ein ganzer Gang.

Diese Untersuchung ergab folgendes Bild: Unabhängig vom Jahr der Entstehung bezifferte sich die Eisterblichkeit bei der ersten Generation im stehenden Holz auf 12,4% $\pm$ m 1,1; 13,9% $\pm$ m 1,5; 12,9% $\pm$ m 0,9 und 11,5% $\pm$ m 0,9. Im nächsten Jahr betrug sie bei der zweiten Generation im stehenden Holz 20,5% $\pm$ m 2,1; 18,8% $\pm$ m 1,9 und 24,4% $\pm$ m 0,9. Im übernächsten Jahr bei der dritten Generation im stehenden Holz wurden 31,3% $\pm$ m 1,8 festgestellt. Die verschiedenen Stufen der Eisterblichkeit konnte man in einem Jahr gleichzeitig vorfinden, da die einzelnen Befallsnester unabhängig voneinander die Gradation durchliefen.

In diesem Zusammenhang erscheint es noch erwähnenswert, dass im zweiten und dritten Jahr immer wieder einzelne Muttergange mit besonders hoher Eisterblichkeit auftraten.

Diese Ergebnisse zeigten eine deutliche Abhängigkeit der Eisterblichkeit vom augenblicklichen Stand der Massenvermehrung in den einzelnen Befallsnestern. Bevor jedoch entschieden werden konnte, ob es sich hier um ein Nachlassen der physiologischen Leistungen handelte, mussten zunächst noch die Umweltfaktoren geprüft werden. Zu diesem Zweck wurden im Schwarzwald und in Hohenzollern zwei eng benachbarte Befallsherde untersucht. Im Schwarzwald betrug im alten Befallsherd die Eisterblichkeit 31,3% $\pm$ m 1,8 und im 80 m danebenliegenden jüngeren Befallsherd 13,9% $\pm$ m 1,5, signifikante Differenz K 7,6. In Hohenzollern, wo die Schadstellen nur 20 m auseinanderlagen, waren die entsprechenden Zahlen 23,3% $\pm$ m 2,0 und 10,8% $\pm$ m 1,0, K 5,5.

Auf Grund dieses Ergebnisses dürfte in diesen beiden Fällen die Witterung

wohl keinen Einfluss auf die Eisterblichkeit gehabt haben. Genau so dürfte wohl das Brutmaterial bei der engen Nachbarschaft im gleichen Bestand keine Rolle gespielt haben.

Da die Differenzen der Eisterblichkeit auch evtl. durch ein Nichtbelegen aller Eigruben und Milbenfrass verursacht sein konnten, wurden 1.414 Eigruben in dieser Richtung untersucht, aber nur 15 Gruben (1,1%) waren nicht mit Eiern belegt und 28 (2,0%) von Milben ausgefressen. Gleichzeitig wurden jedoch häufig glasige, nicht entwickelte Eier gefunden.

Eine Beeinflussung der Eimortalität bei Parasitierung der Altkäfer durch *Ipocoelius seitneri* R. konnte ebenfalls nicht festgestellt werden. Die Sterblichkeit betrug bei

0%	Parasitierung	23,8%
1 - 5%	id.	26,5%
5 - 10%	id.	21,3%
10 - 15%	id.	26,9%
29%	id.	26,7%

Die Eimortalität der ersten und zweiten Brut war 23,3% (n = 137) und 25,8% (n =115), also ein sehr geringer Unterschied.

Auch die für die Populationsentwicklung wichtige Besiedlungsdichte konnte keine Erklärung für die gefundenen Ergebnisse liefern. Die Eisterblichkeit erreichte bei einer Besiedlungsdichte von

150	Muttergängen je qm	23,8%
250	id.	27,4%
350	id.	22,3%
450	id.	26,3%
550	id.	21,6%
1050	id.	26,7%

Für die Eisterblichkeit können wir also zusammenfassend sagen, dass sie im Beobachtungsgebiet durch Milben, Altkäferparasitierung, nichtbelegte Eigruben, Standort, Witterung, Brutmaterial und Besiedlungsdichte nicht wesentlich beeinflusst wurde, sondern in deutlicher Abhängigkeit zum jeweiligen Grad der Gradation stand.

Ein Vergleich der Eizahl je Muttergang brachte ebenfalls Unterschiede hervor. Im jungen Befallsherd (zweite Generation im stehenden Holz) wurden bei gleichen Besiedlungsdichten etwa 40% Eier mehr abgelegt als bei dem älteren Befallsherd mit der dritten Generation im stehenden Holz. Leider war es nicht möglich, eine Untersuchung auf Parasitierung durch Nematoden durchzuführen. Nach FUCHS kann die Eizahl durch Nematodenbefall bis zu 40% gesenkt werden, so dass sich dann im beobachteten Fall kein Unterschied nachweisen liesse. Anhand des bisherigen Bildes möchte ich jedoch nicht ganz dieser Meinung sein.

Als weiteres Zeichen für unterschiedliche Leistungsfähigkeit der Käfer wurde ihr Hungervermögen untersucht. Es war eine erhöhte Sterblichkeit der

dritten Käfergeneration gegenüber der ersten zu beobachten. Leider fehlen auch hier Nematodenuntersuchungen.

Die bisherigen Ergebnisse bezogen sich auf die drei Jahre mit einfacher Generation und die erste Generation 1947. Konnte bis dahin ein ständiges Ansteigen der Eimortalität festgestellt werden, so ergab die zweite Generation eine Überraschung. Im Schwarzwald stieg sie von 11,5% $\pm$ 0,9 m auf nur 16,5% $\pm$ m 1,5 in der zweiten Generation, und in Hohenzollern fiel sie sogar von 19,3% $\pm$ m 1,8 auf 13,4% $\pm$ m 1,0.

Dieses Ergebnis möchte ich folgendermassen erklären:
In Jahren mit gleichbleibender einfacher Generationsfolge ist auch der Selektionsdruck, insgesamt gesehen annähernd gleich. Endogen bedingte Verschlechterung der physiologischen Leistungen der Käfer kann sich hierbei in erhöhter Eisterblichkeit bemerkbar machen. Ändert sich der Selektionsdruck – Anlage einer zweiten Generation – so überschatten hier die günstigen Umweltfaktoren den Genotyp und es erscheint eine Verbesserung der Leistung. Bei der nächsten einfachen Generation hätte sich dann ein verstärkter Rückgang zeigen müssen. Leider konnten diese Untersuchungen nicht mehr durchgeführt werden, da bis zum Frühjahr 1948 das gesamte Käferholz aufgearbeitet war. Auf Grund der anderen Ergebnisse können wir jedoch als sehr wahrscheinlich annehmen, dass bei einem natürlichen Zusammenbruch einer Buchdruckerkalamität auch endogene Faktoren eine Rolle spielen.

DISCUSSION

Mr. **Thalenhorst**: Eigene Untersuchungen bis 1949 im Harz ergaben keine Anhaltspunkte für das Vorliegen „innerer" Mortalitätsfaktoren. Auch Unterschiede der Eiproduktion mussten auf – wenn auch nicht immer leicht zu erkennende – äussere Einwirkungen zurückgeführt werden.

EINE NEUE BEKÄMPFUNGSMETHODE GEGEN IPS TYPOGRAPHUS

von
Bertil LEKANDER
Stockholm, Sweden

In Schweden mit seinen weit ausgedehnten Fichtenwäldern ist der Buchdrucker ständig eine latente Gefahr für die normale Forstwirtschaft. Besonders starke Massenvermehrungen mit nachfolgenden, mehr oder weniger umfangreichen Schäden treten gewöhnlich nach Sturm- oder Schneebruchkalamitäten auf. Dem Buchdruckerschaden am meisten ausgesetzt sind die mittleren und die nördlichen Teile Schwedens.

Als übliche Abwehrmassnahme gegen diesen Schädling hat man in Schweden, wie auch im Auslande, seit langer Zeit die Fangbaummethode angewandt. Diese Methode ist sehr zeitraubend und hat oft – wenigstens bei grösseren Massenvermehrungen – nicht zu gewünschtem Erfolg geführt.

In den letzten Jahren wurden, vor allem in Mitteleuropa, Versuche ausgeführt, den Buchdrucker mit chemischen Mitteln zu bekämpfen. Hierbei kamen sowohl Kontakt- als Magengifte, mit welchen Fangbäume oder bereits befallene Stämme bestäubt oder bespritzt wurden, zur Anwendung. In einigen Fällen wurden hierbei gute Erfolge erzielt, mit keinem der geprüften Verfahren konnte aber meines Wissens eine 100 %-ige Abtötung der zu den Fangbäumen gelockten Tiere erreicht werden. Auch in Schweden haben wir diese Verfahren geprüft, ohne jedoch ein befriedigendes Ergebnis zu notieren. Der Erfolg der Giftfangbaum-Methode setzt u.a. voraus, dass das Gift schnell wirkt, dass die Giftwirkung mit Rücksicht auf die oft lang ausgedehnte Flugzeit des Borkenkäfers dauerhaft ist, ferner dass das Gift regenbeständig ist, dass es auf die anfliegenden Tiere nicht abschreckend wirkt und schliesslich, dass die Methode wirtschaftlich tragbar ist. Die meisten von den bisher vorgeschlagenen Methoden erfüllen nicht alle diese Forderungen.

Bei den Untersuchungen, die Bekämpfung des Buchdruckers zu rationalisieren, haben die Mitarbeiter der Zoologischen Abteilung der forstlichen Versuchsanstalt Schwedens vor einigen Jahren eine neue Methode ausgearbeitet, die den zu stellenden Forderungen genügt und die – nach bisherigen Versuchen zu urteilen – einen völligen Erfolg gewahrleistet.

Die neue Methode besteht in der Hauptsache darin, dass stehende Bäume vor oder nach dem Befall an der Stammbasis vergiftet werden. Das Gift wird mit dem Saftstrom weitergeleitet und breitet sich im Splintholz des ganzen Baumes aus. Nach einer Serie von Vorversuchen mit verschiedenen Giftstoffen und Applikationsmethoden wurden folgende mit vollem Erfolg wiederholt geprüfte Verfahren ausgearbeitet.

1. *Behandlung von bereits befallenen Bäumen*

Die vom Buchdrucker befallenen Bäume werden in ca. 1 m Höhe mit einem besonderen Schälgerät geringelt. Die Ringbreite soll mindestens 5 cm betra-

gen. Auf das freigelegte Holz der Ringe wird sodann eine Paste von einem osmotischen Fluorsalz aufgetragen. Der so behandelte Ring wird danach mit einem Streifen teerimprägnierter Pappe umwickelt und die Pappe an die Rinde festgenagelt. Das Gift wird vom Splintholz absorbiert und mit dem Saftstrom stammaufwärts geleitet. Reagenzproben mit Zirkonoxichlorid + Alizarin-sulphonsäure-Natrium zeigen, dass das Fluorsalz bis zur äussersten Stammspitze hinaufbefördert wird. Kontrolluntersuchungen eine Zeitlang nach der Behandlung zeigen, dass das Brutgeschäft zum Stillstand kommt. Die Mutterkäfer hören mit ihrer Arbeit auf; die Junglarven schlüpfen zwar aus den abgelegten Eiern, sie gehen aber kurze Zeit danach ein. In diesem Zusammenhang ist hervorzuheben, dass die Methode nur dann erfolgreich ist, wenn das Gift bevor die Larven halbwüchsig sind angebracht wird. Dass das Gift in genügender Konzentration bis in die Stammspitzen eindringt, erweist sich ausserdem daraus, dass die Brut des hier lebenden *Pityogenes chalcographus* auch getötet wird. *Crypturgus*-Arten, die an den behandelten Stämmen oft in grossen Mengen auftreten, werden dagegen vom Gift nicht beeinflusst. Mit Rücksicht auf die ausgesprochen sekundäre Lebensweise von *Crypturgus* ist dies indessen wirtschaftlich ohne Bedeutung.

2. *Behandlung von nicht befallenen Bäumen (Fangbäume)*

Diese werden in der gleichen Weise wie oben beschrieben behandelt, doch mindestens eine Woche vor der zu erwartenden Flugzeit. Beim Schwärmen können diese Stämme gefällt und als vorzügliche Fangbäume benutzt werden. Sie werden in gleichem Masse wie die unbehandelten Fangbäume angegriffen und die Borkenkäferbrut stirbt nach relativ kurzer Zeit. Der Vorteil dieser Methode besteht darin, dass man die behandelten Bäume nur zu fällen braucht. Sie können später ohne Aufsicht im Walde liegen bleiben und zu beliebiger Zeit, z.B. im Anschluss an die Hauungssaison im Winter aufgearbeitet werden. Man braucht ferner nicht zu fürchten, dass das Gift durch Regen abgewaschen wird.

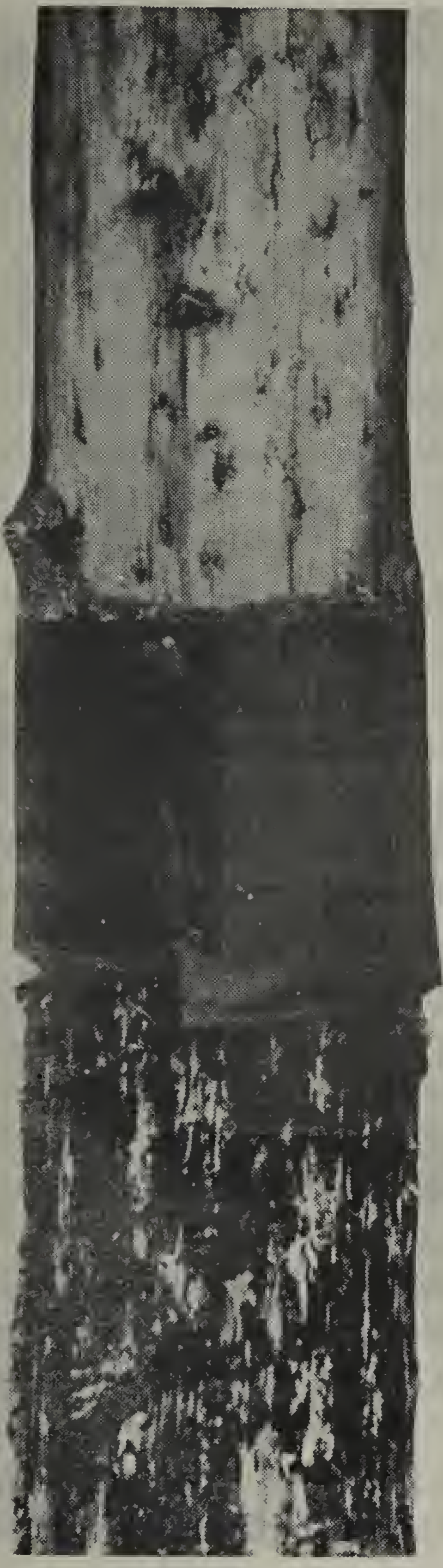
Die Kosten der Behandlung sind nicht hoch. Der Giftverbrauch variiert naturgemäss je nach der Stammdimension, im Durchschnitt kann man aber bei einer Ringbreite von 10 cm mit etwa 70 g je Stamm rechnen (bei 5 cm Ringbreite etwa 40 g). Die Behandlung eines Stammes nimmt etwa 4 Minuten in Anspruch und die Arbeits- und Materialkosten dürften etwa 50 öre betragen.

Statt des Abschälens der Rinde, kann die Ringelung auch mit einem Beil ausgeführt werden, indem rings um den Stamm eine Kerbe schräg nach unten gehauen wird. Dieses Verfahren ist etwa 3 mal so schnell wie die Ringelung durch Schälen, kann aber einstweilen nicht empfohlen werden, da sie bisher keine eindeutige Ergebnisse gezeitigt hat.

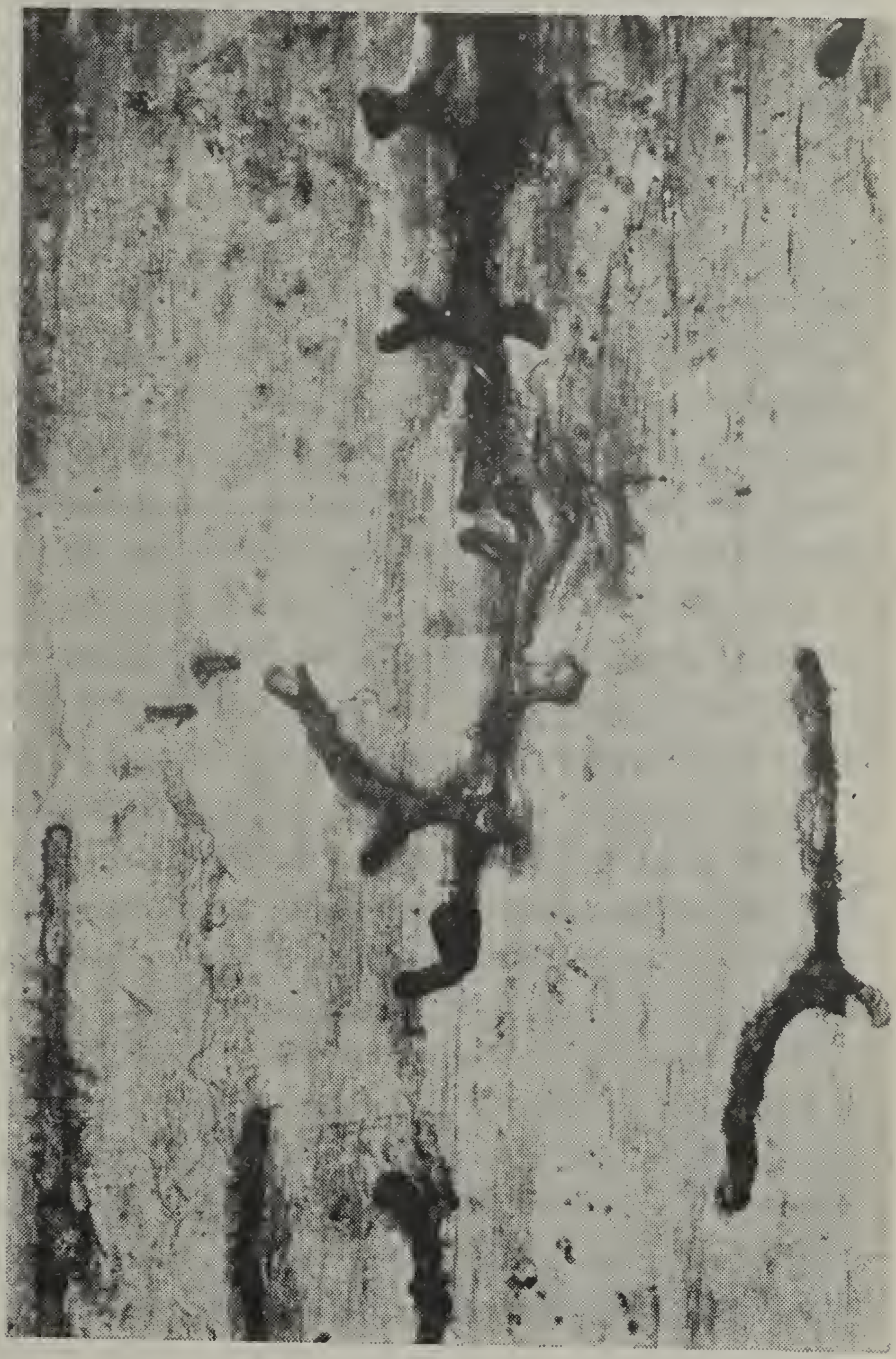
In diesem kurzen Bericht wollte ich die Fachkollegen mit einer Methode zur Bekämpfung des Buchdruckers bekannt machen, einer Methode, die bisher sehr gute Ergebnisse gezeigt hat und die – davon bin ich überzeugt – sicherlich noch weiter entwickelt werden kann.

DISCUSSION

Mr. **Becker**: Ein Angehöriger einer deutschen Holzschutzfirma hat in den letzten Jahren ähnliche Versuche durchgeführt, die erfolgreich waren, wenn die Tiefe der Ringelung richtig war.



n *Ips typographus* befallene Stamm, handelt im Mai. Photographiert im tober. Unterhalb des Ringes normale twicklung, oberhalb keine Entwick-ıg.



Behandelter Fangbaum, 4 m oberhalb des Giftrings. Unregelmässige Frassgänge mit vereinzelten Einischen. Photographiert im Oktober.

DIE DENDROCTONUS-KALAMITÄT IN GUATEMALA

von

Günther BECKER

Berlin-Dahlem, Deutschland

Die Gelegenheit zu den Beobachtungen, über die hier berichtet werden soll, ergab sich dank einem 3 monatigen Aufenthalt in Guatemala im Auftrag der Food and Agriculture Organization of the United Nations.

Guatemala, die nordwestlichste der mittelamerikanischen Republiken, hat eine reiche landschaftliche Gliederung. Von den Gebirgen, die es durchziehen, erreichen die vulkanische Kordillere und die Sierra de Cuchumatanes Höhen über 3500 bis 4000 m. In Lagen über etwa 1000 m ist Nadelwald verbreitet; in den höheren Gebieten über ungefähr 1500 m herrscht er vor. Bis etwa 2000 m Höhe wachsen Pinus caribaea, P. oocarpa, P. patula, P. teocote und P. montezumae; neben ihnen ist, bis zu 2500 m höher hinaufreichend, P. pseudostrobus weit verbreitet. Bis in die obersten Lagen reicht Pinus rudis. Von ungefähr 2500 m an aufwärts sind diese Kiefer und Pinus ayacahuite die häufigsten Arten. Abies relegiosa, Cupressus-, Juniperus-, Araucaria-Arten und andere Koniferen bilden einen bedeutend geringeren Anteil am Waldbestand. – Alle Wälder sind natürlich gewachsen. Künstlichen Anbau gibt es – abgesehen von Cypressenanpflanzungen längs der Strassen – nirgends. Forstliche Kulturmassnahmen werden kaum angewendet.

Seit offenbar schon langer Zeit sind die Kiefern in den Gebirgswäldern Guatemalas durch Borkenkäfer der Gattung *Dendroctonus* bedroht. Waldverheerungen grösseren Ausmasses hat es zuerst in den Mexico-benachbarten Altos Cuchumatanes gegeben. Hier sind vor etwa 20 bis 30 Jahren oder noch früher auf weiten Flächen fast sämtliche Kiefern mit Ausnahme der damals jüngsten vernichtet worden. Noch immer liegen oder stehen die in dem kalten Hochlandklima nur langsam verrotteten Stämme in grossen Massen umher. Gegenwärtig sieht man in diesem Gebirge nur noch stellenweise im nördlichen Teil Neubefall durch *Dendroctonus*.

Das jetzige Zentrum des Befalls befindet sich in der südlicher gelegenen, entlang der Pacific-Küste verlaufenden Kordillere im Raum von Tecpán und Los Encuentros im Osten bis Totonicapán und Quezaltenango im Westen. Hier sind es nicht zusammenhängende Zerstörungsflächen wie in den Altos Cuchumatanes, sondern zahlreiche einzelne, voneinander getrennte kleinere und grössere Nester von einzelnen oder einigen Hundert bis zu wenigen Tausend toten oder befallenen Stämmen an einer Stelle.

Die gefährlichen Primärschäden werden von 3 Arten verursacht: *Dendroctonus adjunctus* Bldf., *D.mexicanus* Hopk. und *D.parallelocollis* Chap. Eine vierte Art, *D.valens* Le C., vermag auch hier nur bereits geschwächte oder gleichzeitig von anderen Schädlingen heimgesuchte Bäume zum Absterben zu bringen. Drei in Guatemala vorkommende *Ips*-Arten sind offenbar nur sekun-

där. Die häufigste und schädlichste primäre Art ist *Dendroctonus adjunctus*. Dieser hier vor 60 Jahren als erste *Dendroctonus*-Art des Landes von CHAMPION entdeckte und von BLANDFORD beschriebene Käfer fand sich im Frühjahr 1951 an allen Befallsstellen; meist war er der einzige oder zumindest der vorherrschende Schädling. Die Beteiligung von *Dendroctonus mexicanus* an der Kalamität in Guatemala ist seit 20 Jahren durch BATES bekannt. *Dendroctonus parallelocollis*, bisher nur im südlichen Mexiko gefunden, konnte neu für Guatemala festgestellt werden.

Die Verbreitung der 3 gefährlichen Arten zeigt eine ausgeprägte Abhängigkeit von der Höhenlage, und damit besonders von den Temperaturverhältnissen. Bei ungefähr 2000 m liegt die untere Verbreitungsgrenze, bei ungefähr 2500 m die untere Grenze für Massenentwicklungen in diesem Lande. Noch bei 3500 m Höhe treten in diesen Tropengebirgen schwere Schäden auf. Der Einfluss der Feuchtigkeit bedarf erst genauerer Untersuchung.

Von den in den gefährlichen Gebirgslagen wachsenden Koniferen wird Pinus rudis regelmässig, Pinus pseudostrobus sehr vereinzelt, Pinus ayacahuite and Abies religiosa nicht abgetötet. Die Gründe für die natürliche Resistenz dieser Arten sind unbekannt. Pinus ayacahuite weicht in Rindenbeschaffenheit, Gerbstoff- und Harzgehalt sowie Duft von den anderen Kiefer-arten weitgehend ab. Die nur in Lagen unterhalb der *Dendroctonus*-Verbreitung vorkommenden Kiefern sind ebenso wenig bedroht wie die hier zum Teil noch wachsende, sonst anfällige Kiefer Pinus rudis. In den Befallsgebieten überstehen jeweils auch einzelne, meist jüngere Bäume dieser Art den *Dendroctonus*-Angriff. Ob es sich dabei um eine individuelle natürliche Resistenz oder um Zufall handelt, muss ebenfalls noch ermittelt werden.

Wie es von anderen Borkenkäfern her bekannt ist, werden auch von den *Dendroctonus*-Arten in Guatemala zunächst geschwächte oder alte Bäume befallen. Bei beginnender Massenentwicklung greifen die Käfer dann aber bald auch völlig gesunde Kiefern an. Sie dringen in den stehenden Stamm zunächst besonders in 3 bis 6 m Höhe im Bereich der unteren Äste ein und bevorzugen in sonniger Lage die Nordseite der Stämme. Später wird der gesamte Stamm ziemlich gleichmässig besiedelt. Die Käfer gehen in starken Bäumen bis zu mindestens 15 m hinauf. Weiter nach oben zu folgen ihnen Ipiden in den abgestorbenen Bäumen.

Die befallenen Stämme reagieren auf das Eindringen der Käfer durch Harzabscheidung und Ausbildung der auch für andere Dentroctonus-Arten wohlbekannten Harzröhren. Pinus rudis zeichnet sich nicht nur durch eine sehr starke, bis zu 6 cm dicke Rinde, sondern auch einen hohen Harzgehalt und heftigen Harzfluss bei jeder Verletzung aus. In gesunden und wuchskräftigen jüngeren Stämmen können zunächst bis zu 1000 vergebliche Einbohrversuche beobachtet werden. Nach kurzer Ganganlage müssen die Käfer entweder dem Harz weichen, oder sie ersticken darin. Erst die nächsten Käferwellen vermögen dann in dem geschwächten Baum mit Erfolg zu brüten.

Die Kiefern bleiben lange Zeit, – mindestens über eine volle Brutgeneration hin, oft wohl noch länger – grün. Dann werden, meist in der Trocken-

Bild 1. Von *Dendroctonus* vor längerer Zeit vernichteter Pinus-Wald in der Sierra de Cuchumatanes (3.000 m Höhe).

zeit, die Nadeln rasch welk und braun. Auf ein anfängliches dunkles Rotbraun folgt ein Farbwechsel der noch lange am Stamm hängenden toten Nadeln in braungelb bis graugelb.

Für das Frassbild von *Dendroctonus adjunctus*, die bisher am wenigsten erforschte Art der Gattung, ist ein vorwiegend gerader oder nur verhältnismässig wenig geschlängelter Verlauf der Muttergänge in Stammrichtung, und zwar meist aufwärts, kennzeichnend. Die Muttergänge können bis zu 1 m lang werden; Längen von 60 bis 80 cm sind sehr häufig. Sie liegen in Kambium und Rinde und schürfen das Holz nur wenig. Die Larvengänge sind sehr kurz, im allgemeinen nur 2 bis 3 cm lang. Sie befinden sich tiefer als der Muttergang in der Rinde, und bei deren Abheben sind die Larven teilweise verdeckt und fallen dann nicht aus den Frassgängen heraus. Die Puppenwiegen werden noch tiefer in der Rinde, nach deren Aussenseite hin, angelegt. *Dendroctonus adjunctus* fügt sich also nicht allein morphologisch – worauf hier nicht eingegangen werden soll –, sondern auch mit seinem Larven- und Verpuppungsfrassbild in das HOPKINSsche Schema an der Stelle seiner geographischen Nachbarn *Dendroctonus mexicanus* und *Dendroctonus parallelocollis* ein. Abweichend von diesen und ein gutes Unterscheidungsmerkmal sind die geraden Muttergänge.

Die Voraussetzungen der *Dendroctonus*-Kalamität in Guatemala weichen nicht von denen in anderen Ländern ab. Die Waldverhältnisse begünstigen die Entwicklung und Übervermehrung der Schädlinge an vielen Stellen sehr. Immer wieder kann man beobachten, wie überalterte, vom Winde gelockerte

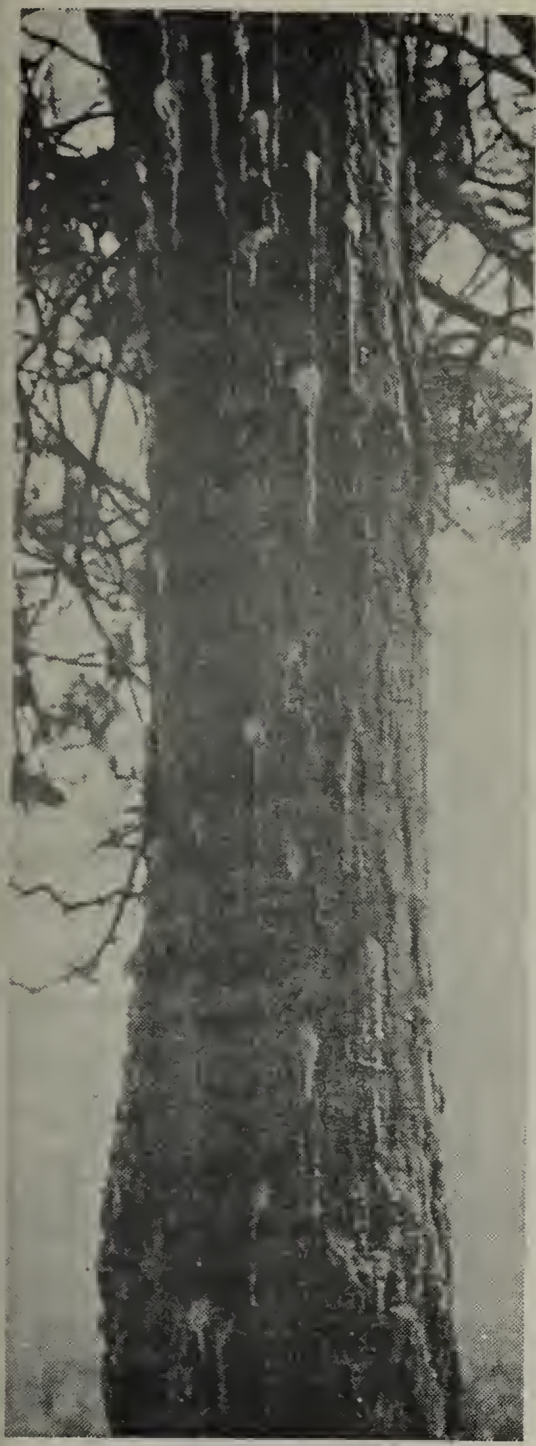


Bild 2. Harzröhren an Pinus rudis nach Erstbefall durch *Dendroctonus adjunctus*.

Bild 3. Frassbild (Muttergänge und Larvengänge) von *Dendroctonus adjunctus* in Rinde von Pinus rudis.

und gestürzte, vom Feuer, durch Verletzungen oder andere menschliche Eingriffe geschwächte Bäume, Stämme nicht fortgeschaffter Einhiebe und besonders auch die oft bis zu 80 cm hohen Stümpfe, die beim Fällen der Bäume mit der Machete zurückbleiben, Ausgangspunkte von mehr oder weniger ausgedehnten Teilgradationen sind.

Abweichend von den sonstigen Erfahrungen mit Borkenkäfer-kalamitäten und daher allgemein interessant ist aber der weitere Ablauf der Gradation. Alle Befallsflächen im Cordellieren-Gebirge, dem gegenwärtigen Hauptschadgebiet, sind räumlich begrenzt und nirgends sehr gross. Zum Teil brütet *Dendroctonus* noch an ihren Rändern, oft hat der Befall aber bereits ein Ende gefunden. Da die ersten grösseren Schäden nachweislich mindestens vor 20 Jahren aufgetreten und sowohl diese alten Zerstörungen wie die gegenwärtigen Brutgebiete stets begrenzt sind, gewinnt man den Eindruck, dass die Teilgradationen ohne Dazutun des Menschen jeweils ein natürliches Ende

gefunden haben und die Kalamität nur langsam voranschreitet. Auf keinen Fall nimmt die Zerstörung hier diesen raschen und ohne menschlichen Eingriff teilweise unaufhaltsamen Verlauf wie es bei gewissen Borkenkäfergradationen in Europa oder Nordamerika zu beobachten war. Fraglich bleibt, ob die wesentlich stärkeren und zusammenhängenden Waldzerstörungen in den Cuchumatanes einen anderen Verlauf genommen haben oder das Ergebnis einer langen Befallszeit sind. Diese Frage konnte nicht verfolgt werden, ist auch vielleicht jetzt nachträglich nicht mit Sicherheit zu klären.

Verschafft man sich durch Auszählen der Harzröhren und Muttergänge einerseits, der Fluglöcher andererseits ein Bild über den Verlauf der *Dendroctonus*-Mortalität in den Gradationsgebieten, so erhält man wesentliche Aufschlüsse. Überall steigt die Mortalität vom Ausgangspunkt des Herdes zu den Befallsrändern hin, und der Zeitpunkt, von dem an weniger Käfer den Baum verlassen, als in ihn eingedrungen sind, scheint verhältnismässig bald nach Beginn jeder örtlichen Übervermehrung zu folgen.

Es liess sich kein Anhaltspunkt dafür finden, dass dieser regelmässige Zusammenbruch der örtlich getrennten Teilgradationen periodisch zusammenfällt, also durch Witterungsschwankungen bedingt ist; vielmehr muss er biotische Ursachen haben. In der Tat ist nun in Guatemala überall, wo nicht einzelne, erste Bäume befallen sind, eine ausserordentlich grosse Zahl von Koleopteren-, insbesondere Cleriden-Larven in den *Dendroctonus*-Frassgängen auffallend. Abgesehen vielleicht von Mykosen, deren Einfluss noch untersucht werden muss, scheinen andere Feinde und Parasiten demgegenüber von untergeordneter Bedeutung zu sein.

Während *Dendroctonus* in Guatemala an der südlichen Verbreitungsgrenze dieser Gattung sich nur noch im Hochgebirge zu entwickeln vermag und hier wahrscheinlich gewissen ungünstigen abiotischen Umweltbedingungen gegenübersteht, ausserdem durch seine primärschädliche Lebensweise laufend starke Ausfälle hat, sind die ihm feindlichen Coleopteren-Arten in diesem Lande nicht allein in einer für nördlichere Gebiete unbekannten Individuen-Fülle vorhanden, sondern anscheinend auch unter günstigen ökologischen Bedingungen.

Der Einfluss der Klimafaktoren auf die Schädlinge und ihre Massenentwicklung bedarf noch der Untersuchung, die jetzt von Prof. Dr. SCHWERDTFEGER fortgesetzt wird. Unabhängig davon zeigt sich aber bereits, dass die *Dendroctonus*-Gradationen in diesem Lande einen für andere Forstschädlinge, nicht aber sonst für Borkenkäfer üblichen Verlauf nehmen. Daraus erklärt sich das verhaltnismässig langsame Fortschreiten der Kalamität in Guatemala.

DISCUSSION

Mrs. **Francke-Grosmann**: In Schleswig-Holstein hat sich *Dendroctonus micans* an Sitkafichte stark vermehrt. Seine natürlichen Feinde in Deutschland

scheinen durch den starken Harzfluss gehemmt zu werden. Hält der Vortragende eine Einführung der *Dendroctonus*-Feinde nach Deutschland zur biologischen Bekämpfung des *D.micans* für aussichtsreich?

Mr. **Becker**: Der Erfolg ist theoretisch schwer voraus zu sagen. Auch gegenüber dem *D.micans* ähnlichen *D.valens* sind die Coleopteren-Feinde in Guatemala anscheinend von viel geringerer Bedeutung als gegenüber *D.adjunctus*, da sich der harzige Inhalt der *valens*-Frassgänge hemmend auswirkt.

DIE BORKENKÄFERKALAMITÄT IM MITTELEUROPA
(Mit Lichtbildern und Film)
von

G. WELLENSTEIN
Ringingen, Deutschland

An der zurückliegenden, gewaltigen Käferkalamität war *Ips typographus* zu 80 %, *Ips chalcographus* zu 15 % und die übrigen Arten, besonders *Ips curvidens* zu 5 % beteiligt. Von 1945 bis 1950 einschliesslich fielen den genannten Schädlingen in Österreich 1,2 Mill., in der Schweiz 0.6 Mill., in Deutschland 23 Mill.cbm Holz zum Opfer. Aus Osteuropa, der Tsechoslovakei, Luxemburg und Frankreich fehlen mir leider die Angaben. In den an Deutschland grenzenden sind aber nicht unerhebliche Holzverluste entstanden. Man wird deshalb nicht fehlgehen, wenn man den Borkenkäferschaden insgesamt mit 30 Mill.cbm. angibt. Wir haben bisher das reichliche Vorhandensein von bruttauglichen, absterbenden Bäumen als wichtigste Voraussetzung einer Ipiden-Gradation angesehen. Neuere Studien haben aber den beherrschenden Einfluss der Witterung gezeigt: Überall, wo die Durchschnittstemperatur in der Vegetationszeit + 14° C überstieg, entwickelte sich *I.typographus* zum Primärschädling, wo sie tiefer lag, behielt der Buchdrucker den Charakter eines sekundären Forstinsekts. Verfolgen wir den Witterungsverlauf so stellen wir fest, dass auf einen warmen Sommer 1937 eine kühle, niederschlagreiche Periode folgte, die erst 1942 einen heissen, trockenen Charakter annahm.

Als extrem günstig für eine Massenvermehrung der Borkenkäfer muss gelten die ganze Vegetationszeit der Jahre 1943, 45, 47, ferner die Frühjahre 1946, 48, 49, sowie die Spätsommer 1944 und 49. Mit Ausnahme des Sommers 1948 fielen die Schwärmzeiten von *Ips typographus* in eine optimale Witterung.

1943, 45, 47 und 49 beträgt für Südbaden die Abweichung der Temperatur von dem langjähr. Mittel der Vegetationszeit + 1 bis 3° C. Die uns aus der Steiermark in Österreich vorliegenden Kurven zeigen ähnliche Werte. Das aber bedeutet eine Temperatursummen-Erhöhung von 180° - 540° C und ein Absinken der Niederschlagssummen von 20 - 70 mm in der Vegetationszeit gegenüber dem langjährigen Durchschnitt.

Die mittleren Abweichungen in der Vegetationszeit (April-September) geben natürlich nur einen groben Einblick in die Verhältnisse! Wissen wir doch durch die Arbeiten von SHELFORD und UVAROV, welchen begünstigenden Einfluss fluktuierende Temperaturen auf die Entwicklung der Insekten haben. Die Temperatur-Extreme, und gerade die für die Borkenkäfer so bedeutsame Strahlungswärme, gemessen an der Sonnenscheindauer, sowie die Verteilung der Niederschläge über die Vegetationszeit lagen in den genannten Jahren

ebenfalls extrem günstig für die Schadinsekten, ganz besonders während ihrer Schwärmzeiten.

Die Borkenkäfer haben hieraus unmittelbaren Nützen gezogen. Aber auch mittelbar kam ihnen diese Witterung zugute: Fichte und Tanne litten unter der anhaltenden Trockenheit und Wärme in umso grosserem Masse, je weiter sich ihr Anbau von den optimalen artspezifischen Standorten entfernt hatte. Dementsprechend waren die Verlüste besonders gross auf den physiologisch-flachgründigen und wasserdurchlässigen Böden der bayerisch-schwäbischen Schotter Hochebene, auf der oberschwäbischen Altmoräne, den heissen, schnell austrocknenden Jura- und Müschelkalkböden, dem warmen Gebiet am Mittelrhein, Main und Bodensee, wo Fichte und Tanne nicht standortsgemäss sind. Prof. SCHIMITSCHEK kommt für Österreich zu dem gleichen Ergebnis: Fichte und Tanne haben dort am schwersten auf den Standorten des ursprunglichen Eichen-Hainbuchenwaldes (*Querceto-carpinetum*) gelitten. Auch der vertikale Bestandsaufbau beeinflusste die Käfer.

Dem gegenüber hat das Vorhandensein mehr oder weniger umfangreicher Rückstände an kranke lndem brutfähigem Holz wohl eine sehr grosse, aber nicht die entscheidende Rolle gespielt die man diesem Faktor für die Entstehung

Käferschaden und vertikaler Bestandsaufbau im Forstamt St. Blasien

Bestandskronenhöhe	über 40 jähr. Fichtenfläche	Käferholz je ha Fichte
gleich	44 %	103 cbm
ungleich	41 %	5 cbm

einer Borkenkäfergradation früher beigemessen hat. Denn kriegsbedingte Rückstande im Holzeinschlag, kleine und grossere Schadstellen durch Sturm, Schneebruch, Artilleriebeschuss und Bomben fanden sich überall.

Es ist damit erwiesen, dass trotz des unterschiedlichen Angebots in den einzelnen Forsten an Brutmaterial und der sehr unterschiedlichen Bekämpfungsintensität zu Beginn der Massenvermehrung eine einheitliche Entwicklung des Käfers in allen Forstbezirken durch das Wetter verursacht und gesteuert worden ist.

Die diesmal zurücktretenden anderen gradationsfördernden Faktoren sollen aber nicht bagatellisiert werden, denn sie können bei künftigen Kalamitäten, die nicht unter derartig günstigen Wetterbedingungen entstehen, sicher erhöhte Bedeutung gewinnen. Sie haben auch diesmal die Ausweitung des Schadens zur Grosskatastrophe mitbestimmt.

Hier sind zu nennen: Das Nichtentrinden des Wintereinschlags 1944/45, in der Ostzone Deutschlands auch noch 1945/46 infolge des militärischen Zusammenbruchs. Die umfangreichen, von ausländischen Arbeitern durchgeführten Exporthiebe bei denen in den wenigsten Fällen Rücksicht genommen würde auf die Weitervermehrung der Borkenkäfer. Auch die ausgedehnten

Sturmwürfe aus den Jahren 1942 und 46 entwickelten sich verschiedentlich zu gefährlichen Brutstätten.

Es kam erschwerend hinzu, dass in den entscheidenden Jahren 1945 und 46, wo es noch möglich gewesen wäre durch energische Abwehr die Massenvermehrung im Keim zu versticken, alle diesbezüglichen Voraussetzungen fehlten. Insbesondere in Deutschland und Österreich verhinderte der durch Zusammenbruch der Verwaltungen und Gefangenschaft bedingte Ausfall an Forstleuten und Waldarbeitern, sowie die auferlegten Beschränkungen im Einschlag und der Verwertung des Holzes zunächst jede planmässige Gegenaktion. Die Sachbearbeiter standen also vor einer selten schwierigen Aufgabe.

Nachstehend sei berichtet, wie sie gelöst wurde.

Biologie und Epidemiologie

Auf biologisch-epidemiologischem Gebiet ist die Erkenntnis neu, dass bei Brutraummangel und grosser Hitze die erstmalig brütenden Käfer in einem weit höheren Prozentsatz als bisher angenommen, zu einer Geschwisterbrut schreiten. Diese wird häufig in einem anderen Baum angelegt. Eine 3 malige Brut derselben Käferfamilie ist nicht erwiesen, aber durchaus möglich. Der heisse Sommer 1947 brachte im Hochschwarzwald 2, im Bodenseegebiet sogar 3 Generationen zur Entwicklung und einen täglichen Befallsfortschritt von max. 20 m im Bestand.

Die Borkenkäfer erwiesen sich im allgemeinen als standorttreu. Ihre Ausbreitung wird bereits durch eine 5 m breite Schneise sichtbar gehemmt. Andererseits sind in Massenvermehrungsgebieten Überflüge festgestellt worden, die der Windrichtung folgend, oft mehrere Kilometer über freies Feld hinweggehen und Neuinfektionen hervorrufen können. Diese Massenschwärme sind, wie die bekannten Überflüge der Nonne, wahrscheinlich eine Übervölkerungserscheinung und wurden regelmässig in den frühen Nachmittagstunden bei heissem, schwülem Wetter beobachtet. Anlockend wirkten besonders im Saft zur Gerbrinde-Gewinnung geschlagene Fichten und unter Wassermangel leidende Bestände. Der Anflugverlust der Käfer ist mit ca. 70% normalerweise gross, kann aber bei heissem, trockenem Wetter sehr gering werden. Der befallene Baum hat dann nicht mehr die Kraft und Zeit, genügend Harz zu produzieren und erliegt dem massierten Angriff, während er bei kühlem und feuchtem Wetter die gleiche Käferzahl infolge ihres über einen längeren Zeitraum verteilten Anfluges abzuwehren vermag. Wenn man berücksichtigt, dass in Nord-Europa Borkenkäferkalamitäten im allgemeinen 3 Jahre nicht überschreiten und dort meist nur eine Generation zur Entwicklung kommt, muss die 7 jährige Dauer der mitteleuropäischen Käferkalamität überraschen, denn sie umfasst insgesamt mindestens 10 Generationen. Verfolgen wir den zeitlichen Verlauf an der einzelnen Schadstelle, so zeigt sich, dass die Vermehrung nach 3 Jahren örtlich zusammenbricht. In der Eisterblichkeit, die von Jahr zu Jahr um 10% ansteigt, glauben wir einen Weiser gefunden zu

haben für den örtlichen Zustand der Gradation. Da diese Sterblichkeit nicht durch Parasiten oder Raumnot verursacht ist, möchten wir sie als endogenen Faktor ansehen. Das weitere Fortschreiten der Käferkalamität im Grossen wäre demnach zurückzuführen auf überwiegend autochthone Einzelgradationen, die zeitlich gegeneinander verschoben sind und in sich gesetzmässig ablaufen. Unabhängig von einander haben verschiedene Fachwissenschaftler entdeckt, dass die Jungkäfer des Ips typographus an sonnigen Wintertagen sich aus den stehenden Stämmen ausbohren und auch durch die Schneedecke den schützenden Waldboden erreichen. Diese Überwinterung kann durch mangelhafte Bekämpfung des käferverseuchten Holzeinschlages während der Herbst- und Wintermonate einen grossen Umfang annehmen. Probesuchen ergaben bis zu 6.200 gesunde Jungkäfer je qm. Im Frühjahr suchten diese Käfermassen die nächstliegende Möglichkeit, um den unterbrochenen Reifefrass abzuschliessen. Auf Kahlflächen sammelten sie sich in unvorstellbaren Massen an den Stöcken, liegen-gebliebenen Stamm-Stücken und Ästen. Der Zeitpunkt dieses Reifefrasses lag im Allgemeinen zwischen dem Austreiben der Lärche und Rotbuche. Durch diese Entdeckung wurde die bisher empfohlene Winterbekämpfung fragwürdig.

Bekämpfung

Die Abwehrmassnahmen litten in den ersten Jahren unter dem Fehlen einer zentralen Lenkung und namentlich unter einem bis 1948 fühlbaren Mangel an Waldfacharbeitern. Eine straffe Bekämpfungsorganisation wurde schon in 1946 in Österreich, Bayern und Würtemberg, dagegen erst 1949 in der Ostzone geschaffen. Der Mangel an Arbeitskräften forderte die Entwicklung neuer, wirtschaftsintensiver Bekämpfungsmethoden. Je nach Straffheit der Organisation setzten sich die Ansichten der wissenschaftlichen Berater schneller oder langsamer in der Praxis durch. Schon im Frühjahr 1947 zeichneten sich klar 2 unterschiedliche Auffassungen ab:

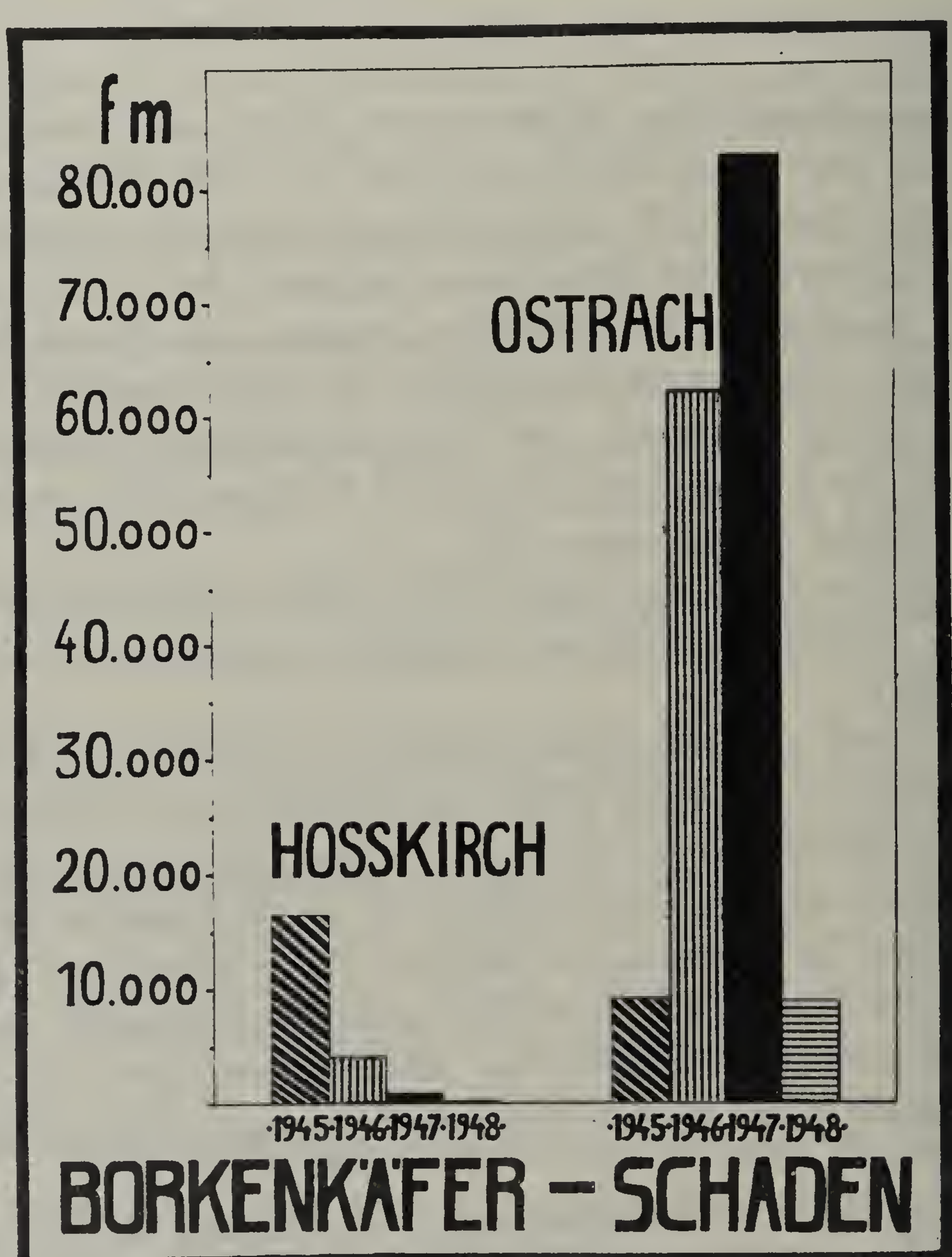
Die eine Gruppe der Fachwissenschaftler stand einer zusätzlichen Anwendung chemischer Präparate zunächst skeptisch gegenüber und gab deshalb folgende Richtlinien:

Der Käfer ist durch schachbrettartig über die Nadelholzbestände verteilte Fangbäume zu überwachen, verseuchte Grossflachen sind spätestens im Winter aufzuräumen und müssen durch breite Fangschläge gegen die gesunden Bestände abgeriegelt werden. Das Fangholz ist im Brutstadium auf Tücher zu entrinden, die Rinde ist sofort zu verbrennen. Durch ständiges Absuchen der gesunden Waldteile muss der Neubefall rechtzeitig erkannt und beseitigt werden. Diese Ratschläge entsprachen alten Erfahrungen. Sie verlangten hohe Opfer an Fangholz und trugen dem Arbeitermangel nicht genügend Rechnung.

Demgegenüber vertrat der Berichterstatter von Anfang an die Auffassung, dass es nicht möglich ist, mit wirtschaftlich tragbaren Fangholzmengen verseuchte Grossflächen abzuriegeln, sondern dass diese nur durch Abbrennen

oder Vergiften der Stöcke und Äste während des Reifefrasses der Käfer im Mai entseucht werden können.

Liegt das Fangholz im zu schützenden Bestand, so infiziert es auch die gesunden Bäume. Es ist also auf Freiflächen, möglichst in NS-Richtung zu legen und gegen direkte Besonnung teilweise mit grünem Reisig zu bedecken. Gegen *Ips chalcographus*, *Vorontzowi* und *Cryphalus piceae* haben sich Fangreisighaufen sehr bewährt. Die 1946 begonnenen Versuche, Käfer und Brut durch Bespritzen der nicht entrindeten Stämme mit 5 % iger Kalkarsenatbrühe zu töten, zeigten eine zwar langsame, aber vollständige Vernichtung aller Schädlingsstadien. Zweifel in die Wirksamkeit und hygienische Bedenken erschwerten eine schnelle Verbreitung des Verfahrens. Wo es jedoch Vorbehaltlos und richtig angewendet wurde, erwies es sich allen anderen Abwehrmethoden als weit überlegen. Demgegenüber hat die zusätzliche Verwendung staub- oder nebelförmiger Kontaktgifte zum Schutz bedrohter Bestände und in Verbindung mit dem Entrinden nur bei warmtrockenem Wetter befriedigt. Diese neuartige Bekämpfungsweise fuhrte zu einer betrachtlichen Ersparung an Arbeitskräften, Zeit und Fangholz, brachte ader keine Verbilligung.



Forst *Hosskirch* = radikale chemisch-mechanische Bekämpfung 1946/47 auf Kalkarsen-Grundlage. Forst *Ostrach* = reine mechanische Bekämpfung mit viel Fangbäumen. Radikale Bekämpfung erst ab 1948. (Beide Forsten grenzen aneinander, haben gleiche Standort- und Bestandsverhältnisse)

Die erzielten Erfolge (s.graph.Darst.) haben dazu geführt, dass sich dieses kombinierte Verfahren gegen alle Bedenken in ganz Südwest Deutschland und Österreich durchgesetzt hat. Zu gefährlichen Erkränkungen von Waldarbeitern ist es nicht gekommen. Die Vieh- und Wildverluste durch Arsen blieben unbedeutend.

Unsere Bemühungen, dem Käfer im stehenden Holz durch Emporleiten von Giftstoffen mit dem Saftstrom zu vernichten, gehen auf das Frühjahr 1946 zurück, erzielten aber erst im Frühjahr 1948 Erfolge. Aus dem Referat von Herrn Dr. LEKANDER haben wir erstmalig davon gehört, dass in Schweden der gleiche Weg mit Erfolg beschritten worden ist. Wir haben zunächst mit Pasten-Bandagen eines Holzimprägnierungsmittel „Osmolith U" die Käfer vollständig abgetötet und zwar durch Vergiftung der stehenden Bäume vor Befall. Im Zuge der Weiterarbeit erwiesen sich 2 malige Anstriche des ringförmig freigelegten Splintholzes in 1 m Stammhöhe als wirtschaftlicher. Verwendet wurden 15–25% Lösungen von Natriumarsenit, Natriumarsenat oder Natriumfluorid. Interessant ist, dass auch aus bereits frisch befallenen Bäumen sich täglich 50-100 schwer kranke Brutkäfer ausbohrten und auf dem Waldboden verendeten. Die Wirkung ist nur vollständig, wenn die Brut noch nicht zu weit entwickelt und die Saftzirkulation dadurch unterbrochen ist. Voraussetzung für den Erfolg ist also ein frühzeitiges Erkennen des Befalls. Im Grosseinsatz beliefen sich die Kosten auf nur 25 Pfg. je Stamm, der Zeitaufwand auf 5 Arbeitsminuten. Das Verfahren ist somit im durchschn. das 8 fache billiger und zeitsparender als die bisher üblichen Bekämpfungsmethoden. Der Borkenkäfer-Ökologie spezifisch angepast ist, das Hochleiten von Giftstoffen mit dem Saftstrom auch Waldhygienischer als das Bestauben oder vernebeln der Berührungsgiften auf grossen Flächen. Ich konnte zu Beginn dieses Kongresses leider noch nicht anwesend sein und hatte gehofft, Ihnen mit dem letztgenannten Verfahren etwas Neues mitzuteilen. Nun sehe ich, dass unsere Kollegen in Schweden unabhängig denselben Weg gegangen sind, dessen Richtigkeit ich Ihnen nur bestätigen kann. Die Borkenkäferbekämpfung gewinnt damit eine umwälzende Änderung. Der Weg über die Saftbahnen des lebenden Baumes eröffnet auch auf dem Gebiet des Pilzschutzes und der Forstbenutzung grosse Möglichkeiten, wie die teilweise schon Jahre zurückreichenden Imprägnier- und Entrindungsversuche Kanadischer und Deutscher Holzspezialisten gezeigt haben.

Die aus einer unseeligen Verkettung von vermehrungsgünstigem Wetter, Kriegsfolgen, waldbaulichen Fehlern und anderen menschlichen Unzulänglichkeiten entstandene Borkenkäfer-Katastrophe ist zu Ende gegangen. Sie hat der europäischen Forstwirtschaft Millionen cbm Holz gekostet. Sie hat uns aber auch wichtige Erkenntnisse gebracht und den Beweis, dass es selbst in aussichtslos erscheinenden Situationen möglich ist durch überlegtes Einsetzen der modernen Bekämpfungsverfahren Millionen cbm Holz vor der sicheren Vernichtung zu bewahren!

BILDLICHE DARSTELLUNG DER VERTILGERKREISE EINIGER FÖRSTLICHER GROSSSCHÄDLINGE UNTER DEN INSEKTEN

von

Frhr. VON VIETINGHOFF-RIESCH

Göttingen, Deutschland

Im Forstzoologischen Institut der Universität Göttingen, das derzeit zu vertreten ich die Ehre habe, sind auf meine Veranlassung hin 6 Tafeln entstanden, die den Vertilgerkreis von 5 forstlichen Grossschädlingen: Maikäfer (*Melolontha melolontha* L. und *Melolontha hippocastani* F.), Buchdrucker (*Ips typographus* L.), Nonne (*Lymantria monacha* L.), Eichenwickler (*Tortrix viridana* L.) und Forleule (*Panolis flammea* Schiff.) darstellen. Sie sollen vor allem Unterrichtszwecken dienen, weshalb auch bei der Darstellung der Vertilger jeweils verschiedene Schemata angewendet wurden, um keine Eintönigkeit aufkommen zu lassen. Da bei einigen dieser forstschädlichem Insekten die Zahl der vertilgenden Organismen einschliesslich Pilzen und Viruskrankheiten eine sehr grosse ist, wurde in solchen Fällen davon Abstand genommen, jeden einzelnen bildlich darzustellen. Statt dessen wurden Repräsentanten gewählt, während die übrigen nur mit ihrem Namen erscheinen oder sogar nur nach ihrem Artenreichtum aufgeführt werden.

Wie jede Darstellung, so soll auch diese durch Erklärungen erst lebendig gemacht werden. Während bei der Darstellung des Maikäfervertilgerkreises noch eine ziemlich schematische Darstellungsweise zur Anwendung kam, wurde bei späteren Tafeln mehr zu einer Darstellung des Vertilgers in seiner Aktion übergegangen, wobei sogar das illustrative Moment nicht ausgeschaltet wurde (siehe Borkenkäfertafel).

Bei der Kommentierung der Tafeln muss, um Missverständnisse, denen der Betrachter sonst unterliegen kann, zu vermeiden, auf folgendes hingewiesen werden:

1. Mit der Darstellung soll nicht gesagt werden, dass die Wirksamkeit der einzelnen Vertilger eine gleichwertige sei. Nur bei der Maikäfertafel kam die Differenzierung durch Anwendung verschieden starker Pfeile einigermassen zur Geltung.

2. Der Vertilgerkreis bedeutet keine absolut sicher funktionierende Einengung des Schädlings in die Populationsdichte des sogenannten eisernen Bestandes, er besitzt aber unter normalen ökologischen und klimatischen Verhältnissen, d.h. so lange die Umwelt des Forstinsektes einen hohen Natürlichkeitsgrad besitzt und noch keine Verschiebung zu Gunsten chronischer Massenvermehrungen des Insektes und zu Ungunsten seines Vertilgerkreises eingetreten ist, eine bedeutende prophylaktische Wirkung. Diese ist wohl imstande, die Intervalle zwischen den sonst unvermeidlich häufiger auftretenden Gradationen zu verlängern, und zwar umso mehr, je weiter wir uns vom Zentrum der klimatisch bedingten Schadgebiete entfernen.

Was die einzelnen Tafeln betrifft, so spricht die Darstellung für sich selbst. Aus Gründen wissenschaftlicher Prägnanz und um auch Jagd und Naturschutz zu ihrem Recht kommen zu lassen, wurden selbst jene höheren Tiere bildlich dargestellt, von denen man weiss, dass der betreffende Schädling mit zu ihrer Ernährung gehört, die aber so selten sind, dass ihr Anteil innerhalb der Kommensalen nicht mehr gewertet werden kann.

Bei der Darstellung des Nonnenvertilgerkreises musste für Parasiten und Räuber einerseits, Vögel andererseits, je eine besondere Tafel angefertigt werden, um die Übersichtlichkeit zu wahren, wobei trotzdem noch auf eine grosse Zahl von Parasiten nur durch Bemerkungen hingewiesen werden konnte. Bei der Darstellung der Vögel konnte nur auf den jetzigen Stand unseres Wissens zurückgegriffen werden; der innere Kreis zeigt die Hauptvertilger (von einzelnen Forschern auch „Arbeitsvögel" genannt), der äussere Kreis diejenigen Vögel, die als Vertilger entweder erst in 2. Linie gewertet werden können oder nur dann in Erscheinung treten, wenn bei Massenvermehrungen wahllos alle Bestandstypen und Holzarten befallen werden.

THE EUCALYPTUS BORER (Phoracantha semipunctata F.) IN ISRAEL

by

H. BYTINSKI-SALZ and S. NEUMARK

Jaffa, Israel

The Eucalyptus borer (*Phoracantha semipunctata* F.) is a native of Australia, where it is found not uncommonly in natural Eucalyptus woods, and chiefly known as a pest attacking felled timber. It was introduced into a number of subtropical countries as New Zealand, South Africa, Argentine and Chile and reached Palestine probably during the early Forties. It was first observed in 1945 in two different places at a distance of about 60 km from each other (indicated by triangles in fig. 1), and a survey in 1946 showed, that it was already present in most of the regions where Eucalyptus groves are planted, chiefly in the Coastal plain, the plain of Jesreel and the upper Jordan valley. During recent years it has penetrated somewhat southwards, but the environments of Jerusalem and the lower Jordan valley still seem to be free, as well as the Southern steppe (Negev) where only isolated groves or young trees along the roads exist (Fig. 1). In 1949 it was introduced, probably with timber for construction purposes, into the oasis

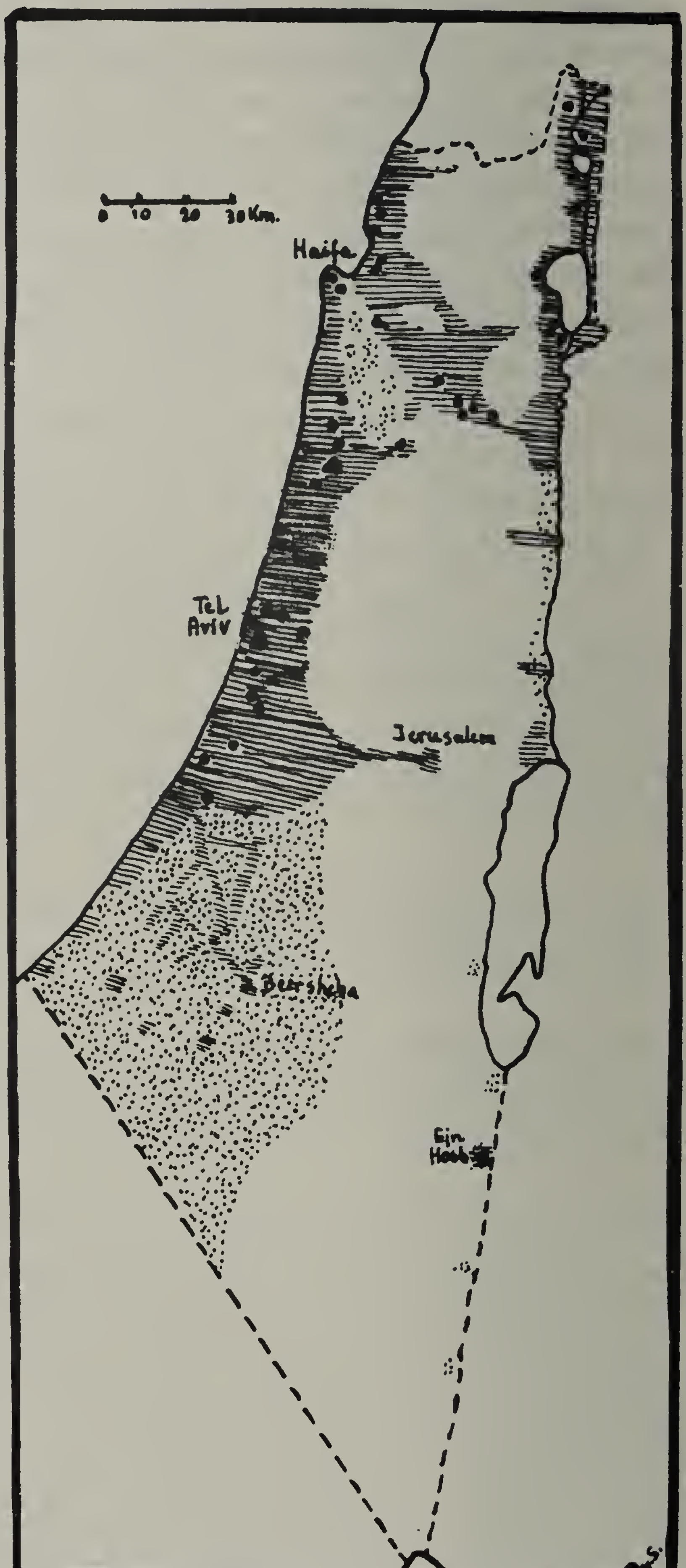


Fig. 1. *Map of the Land of Israel.* Hatched: the regions where Eucalyptus is now grown. Stippled: regions suitable for Eucalyptus growing. Dots: Occurrence of Phoracantha.

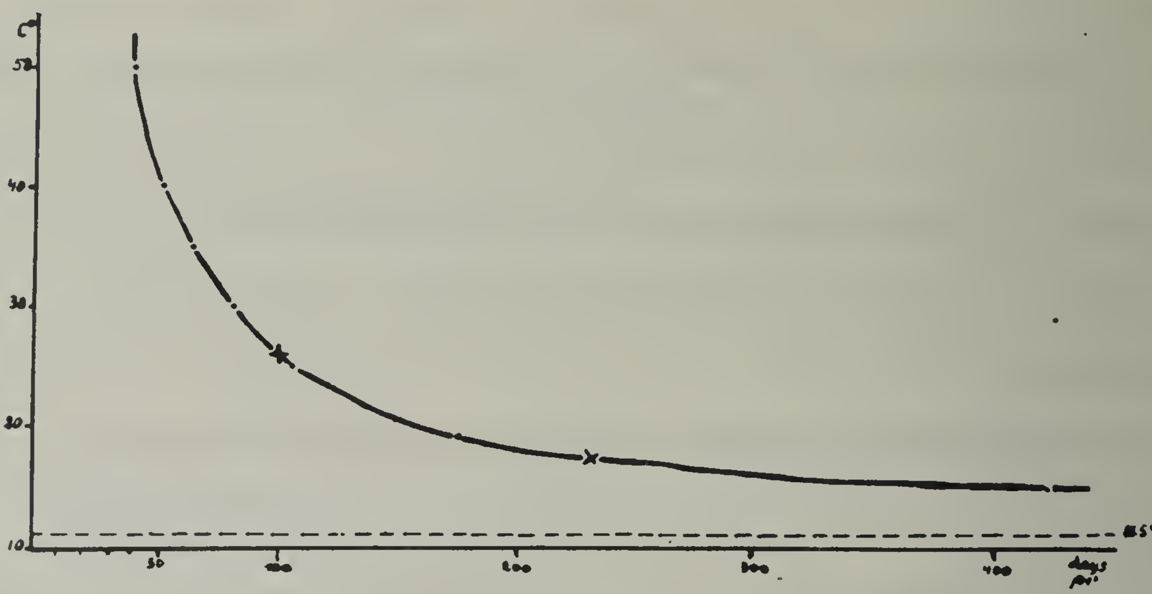
"Ejn Hosb" south of the Dead Sea, where it killed a number of trees growing there, thus showing, that it may adapt itself also to severe desert conditions.

The potential use of Eucalyptus wood in Israel for timber and pulp is great and latest reports show, that with the help of a few irrigations during the first two years, it can be established as an important tree in the afforestation scheme in the vast area of the Southern steppe. It is therefore of great interest to study its physiology together with the bionomics of its only serious pest: *Phoracantha*.

Contrary to its habit in other countries, where *Phoracantha* is chiefly known as a pest of felled timber, it attackes in Israel standing living trees from 5 years on which are completely girdled. Trees up to 12 years usually succumb to the attack, owing to the complete destruction of the cambium and phloem, older trees, the circumference of which are not entirely girdled, may survive the primary attack, but are weakened and therefore attacked with preference by later generations. The beetles are chiefly active during night, hiding in daytime under the dry bark or in crevices. Longevity of the adults is about 40 days in summer and up to 180 days during the colder season. Below a nightly minimum temperature of 15° C egglaying stops and is resumed at 16.2° C but as egglaying begins shortly after dusk, the threshhold of oviposition may be a few degrees higher. Oviposition occurs practically uninterruptly from March to November and the eggs are deposited in batches of 10-110 (average 43,5) either under the loose outer bark of standing trees or on the underside of logs touching the soil. The number of eggs laid per female can only be estimated at about 300, the maximum number laid by caught specimens. Bred females fed on honey or carobs syrup always laid a smaller number of eggs, probably because the optimal food in the laboratory has not yet been found. The Thermal Constant for egg development is 47,5 day degrees C.

The larvae bore immediately into the bark, where they penetrate down the newly formed wood, eating from the inside the cambium, phloem and inner young bark. As they grow in size, their tunnels expand more and more around the circumference of the tree till the stem is girdled about 50 cm above or below the point of entrance. The tunnels of older larvae are so close to each other that only ridges of about 1 mm live plant tissue remain between them, which is not enough for the tree to reestablish sap circulation. The mature larva bores into the older wood, where it forms a vertical pupation chamber about as long as the larva. Thermal Constants for larval and pupal developments are 885 resp. 525 daydegrees C.

The emerging beetle eats its way back through the larval borings, tightly packed with sawdust and hatches through an oval hole about at the place where the mature larva penetrated into the wood. The whole time of development from the egg to the hatching of 50% of the adults takes at 18,5° C - 246 days and at 26.5° C - 98 days from which may be calculated the Thermal Constant of 1566,7 daydegrees C; the threshold of development is 11.5° C.



Hyperbola of Development of Phoracantha. Egg to hatching of 50% of the adults.
Fig. 2

BLUNCK's hyperbols of development is shown in fig. 2. Therefore 2 generations are possible under the climatic conditions of the Coastol zone and observations in the field affirm this, showing 2 overlapping generations, one from March to August and a second from September to April.

Sofar no effective parasites are recorded from Israel. Wood sanitation and trap trees are recommended. Trap trees are attacked only after the second

	8.X.50– 7.I.51	8.IV.50 – 6.VII.50						
week	A	L	M	N	O	P	Q	R
I	16	8						
II	18	15						
III	4	11	28					
IV	8	3	11	26				
V	5	9	44	45	67			
VI		1	7	21	37			
VII		3	4	14	22	105		
VIII		2	-	8	3	24	37	
IX		-	11	7	8	45	68	
X		4	6	7	4	4	16	19
XI	2	3	-	-	1	12	16	114
XII		-	4	1	4	8	6	43
XIII		-	-	-	-	8	6	39
Total number of eggs about	530	550	1150	1290	1460	2060	1490	2150

Table: Number of eggs in units of tens laid on trap logs.
A = in winter; L–R in late spring and summer.

night after felling and remain attractive for many weeks, in wintertime even after 3 months. Older logs are less attractive then newly felled ones if these are placed near them, as can be seen from the foregoing table. In this the number of eggs had to be estimated in units of tens, as they are often laid in clumps one above the other.

The maximum number of eggs found on one log was more than 2000, which may correspond to the presence of about 30 laying females. On one log of 2 m length and 15 cm diameter some 1000 eggs were laid within one month and from these 150 adults emerged.

Sofar *Phoracantha* is known to attack *Eucalyptus rostrata,* the tree chiefly grown in Israel and also four other *Eucalyptus* species. As only part of the trees in a grove are attacked at one time and not all groves are infested in the same degree, the question arises how far physiological conditions may influence the vulnerability of the tree. Besides evidently weakened trees, also apparently vigorous trees may succumb to the attack - but in these cases the weakening may have been so insignificant as to being perceived only by the borer. That physiological conditions may be one factor, is indicated by cases where part of the grove was irrigated by refuse water. When the course of the water flow was altered a heavy attack on almost all of the trees formerly irrigated occurred, but the rest of the grove showed little infestation.

Since October 1950 trees have been infected with larvae in biweekly intervals but sofar no infestation was achieved. The larvae readily entered the bark, but no borings longer than 5 cm were found and all the larvae were killed by heavy gum secretion. Also in trees girdled and infected above the girdle, no development resulted from the introduction of the larvae. Further experiments must be carried out to define more exactly the conditions under which the trees are attacked and than, perhaps, means can be found to prevent the occurrence of these conditions.

DIE ROTE WALDAMEISE UND IHRE VERMEHRUNG IM DIENSTE DER WALDHYGIENE (mit Film über die Massenzucht von Königinnen und Kolonievermehrung)

von

Karl GÖSSWALD
Würzburg, Deutschland

In einem natürlichen Lebensraum nehmen die dort verbreiteten Pflanzen- und Tierarten einen Anteil an der Nutzniessung, der ihren eigenen Fähigkeiten und den jeweils herrschenden Umweltbedingungen entspricht. Alles gegenseitige Einwirken der sehr verschiedenartigen unbelebten und belebten Einzelfaktoren stellt ein Streben nach einem Gleichgewichtszustand dar.

Im Kulturbereich des Menschen aber sind viele Pflanzen- und Tierarten vom Menschen ausgerottet worden. An der Stelle der artenreichen und daher ausgeglichenen Lebensgemeinschaft entstanden gleichartige und gleichaltrige Monokulturen der Nutzpflanzen. Diesen Lebensraum hat der Mensch gegen das Naturgesetz gestaltet, hier kann weder von Einheit, noch von Ganzheit, Natürlichkeit oder Harmonie die Rede sein. Aber an den Folgen erkennen wir, dass auch der Naturbereich des Menschen den allgemein gültigen Naturgesetzen unterworfen ist. Die in den Nadelholzmonokulturen immer wieder auftretenden Schädlingskalamitäten sind das Ergebnis eines z.B. durch Kahlschlag rücksichtslos zerrissenen Lebensgeflechtes und somit Folgeerscheinungen der ständig wieder auf ein neues Gleichgewicht hinstrebenden Natur.

Im Gegensatz zur Kultursteppe verfügt der Kulturwald noch über so viel natürliche Potenz, dass hier erstens durch geeignete Mischung des Baumbestandes nach Art oder wenigstens nach Alter und zweitens durch Wiederanreicherung der vom Menschen ausgerotteten natürlichen Nutzniesser der Schadinsekten die Ausgeglichenheit des Lebensraumes wieder hergestellt werden kann. Zum Ausgleich der Lebensgemeinschaft hat der Vogelschutz bereits Vorbildliches geleistet. Die wirkungsvollsten Feinde der Schadinsekten stehen aber in dem Reich der Insekten selbst. Hier nimmt die Rote Waldameise eine Grossmachtstellung ein, bezw. sie könnte sie einnehmen, wenn sie nicht durch den Menschen selbst bis auf geringe Reste ausgerottet worden wäre.

Die Hilfe der Roten Waldameise gegen die Waldverderber ist von der vielseitigen nutzbringenden Tätigkeit dieses Raubinsekts am wichtigsten für die Waldwirtschaft; das beweisen besonders eindringlich die bei Insektenkalamitäten von den Ameisen geretteten grünen Oasen inmitten des ringsum von Nonne, Kieferneule, Kiefernspinner oder Kiefernspanner kahlgefressenen Waldes. Hier hat die Natur selbst das beweiskräftigste Experiment für den Nutzen der Roten Waldameise geschaffen. Einzelkolonien der Ameisen haben hier dem Ansturm von Millionenmassen der Schädlinge standgehalten, die sich in der weiteren Umgebung ungestört vermehren konnten und daher in un-

natürlich grosser Zahl auch den Jagdbereich der Waldameisen überflutet haben. Wenn also unter derart ungünstigen Bedingungen die Waldameisen gleichwohl den Wald im Umkreis von 3 ha um ihre Kolonie vor jedem Schadfrass bewahren, dann dürften sich bei Wiedervermehrung der Roten Waldameise zur natürlichen Siedlungsdichte die bisher vereinzelt geretteten Inseln zu einem gesunden grünen Wald zusammenschliessen.

Noch etwas Wichtiges lehren uns die geretteten grünen Inseln, und zwar die Tatsache, dass die Schädlingskalamitäten durchaus nicht nur waldbaulich, sondern nicht zuletzt auch biozönotisch, nämlich durch das Fehlen der Roten Waldameise begründet sind; denn diese Nutzwirkung tritt je in den gleichartigen und gleichaltrigen Nadelholzwäldern zutage. Andere Nützlinge, auch die Vögel, sind zu solchen Leistungen nicht in der Lage.

Die Grossmachtstellung der Roten Waldameise stützt sich zunächst auf ihre Eigenart als soziales, staatenbildendes Insekt und ihren ungeheuren Individuenreichtum. Zu dieser Massenwirkung der Millionenvölker kommt eine körperliche Überlegenheit, ein stark ausgeprägter Raubinstinkt, eine sehr hohe psychische Veranlagung, welche Zusammenarbeit bei der Erbeutung stärkerer Feinde ermöglicht, dazu ein eigener Klimahaushalt im Nest, welcher Jagd zeitig im Frühjahr bis in den Dezember ermöglicht, und zwar gegen sämtliche Entwicklungsstadien der Schädlinge: Ei, Larve, Puppe und Vollkerf, sowohl unter dem Boden, auf dem Boden und auf den höchsten Baumkronen in einem Umkreis bis zu 500 m. Besonders wesentlich ist schliesslich ein eigener Nährungshaushalt, der die Waldameisen unabhängig von den Schadinsekten und daher einsatzbereit gegen diese macht, während z.B. Parasiten erst auf die Vermehrung der Schädlinge als Wirte angewiesen sind und daher vielfach der Kalamität nachhinken. Der eiserne Bestand der Ameisen zu insektenarmen Zeiten sind die Rindenläuse, deren süsse, zuckerhaltige Exkremente die Ameisen einsammeln. Dabei schaden die Rindenläuse dem Nadelwald gar nicht, wie nicht nur langjährige Beobachtungen an den gesundheitsstrotzenden, besonders üppigen Rindenlausbäumen, sondern auch Untersuchungen meines Schülers Dr KLOFT gezeigt haben, der nachweisen konnte, dass der Speichel der Rindenläuse sehr im Gegensatz zu den Sekreten der schädlichen Pflanzenläuse das Wachstum von jungen Kressewurzeln nicht beeinträchtigt, sondern eher fördert.

Obwohl die Waldameise sich auf auffallend häufige Insekten spezialisiert und ihre Übervermehrung zu schädlich werdenden Massen unterdrückt, rottet sie die Fauna keineswegs aus, sondern trägt sogar zur Artenanreicherung bei, zunächst durch Verbreitung von Pflanzensamen, je mehr Pflanzensamen, je mehr Pflanzenarten, je mehr Insekten und unter ihnen viele nützliche. Auch Vermehrung der nützlichen Singvögel konnte in den Ameisenwäldern deutlich festgestellt werden, für die Vögel bedeuten die Ameisen eine gleichmässig zur Verfügung stehende Nahrungsquelle, ohne dass den Millionenvölkern der Ameisen diese kleine Einbusse merklich schadet. So ermöglicht die Rote Waldameise in der Nützlingsbiozönose des Waldes eine räumlich und zeitlich festgefügte Kette um die Schädlinge und sie selbst

bildet das entscheidende Schlüsselglied: fehlt die Rote Waldameise, dann ist die Kette offen, die übrigen Nützlinge vermögen die Massenentfaltung der Schädlinge nicht aufzuhalten; ist die Rote Waldameise einsatzbereit, dann ist die Kette der Nützlinge fest um die Schädlinge geschlossen und deren einseitige Übervermehrung unmöglich gemacht.

Die Stetigkeit dieses Nutzens der Roten Waldameise ist nicht nur durch den Klima- und Nahrungshaushalt, sondern auch durch die potentielle Unsterblichkeit der Kolonien gerade der besonders räuberischen und individuenreichen Kleinen Roten Waldameise begründet. Die Völker der Grossen Roten Waldameise sterben nach dem Tode ihrer einzigen Königin, die etwa ein Alter von 20 Jahren erreichen kann, aus. Ein Nest der Kleinen Roten Waldameise dagegen kann einige Tausend Königinnen enthalten, hier werden junge begattete Weibchen immer wieder dem Bestand der alten Königin einverleibt, während bei der Grossen Roten Waldameise alle jungen Weibchen sofort nach der Begattung getötet werden, wenn sie nicht rechtzeitig aus dem Bereich der Mutterkolonie entkommen.

Der Vielzahl der Königinnen entspricht bei der Kleinen Roten Waldameise eine Vielzahl von Nestern, die sich immer weiter durch Schwarmbildung verjüngen und aufteilen können, so dass die Wälder bei hinreichendem Schutz der neu ausgesetzten Kolonien von selbst allmählich mit einem dichten Netz von Waldameisen-Nestern angereichert werden. So brauchen also die grossen nestreichen Kolonien der Kleinen Roten Waldameise niemals auszusterben und die bisher ameisenfreien, insektengefährdeten Wälder werden lückenlos und in ununterbrochener Folge auf einfachen, natürlichen und daher zuverlässigem Wege vor Schadfrass bewahrt.

Auf die zahlreichen wichtigen Art- und Rassenunterschiede, deren Kenntnis erst den Grund gelegt hat, zu einer richtigen Einschätzung des Nutzens und zur Ermöglichung der Kolonievermehrung, kann nicht im einzelnen eingegangen werden; die Arten werden in grösserem Rahmen in einem Buch über die Rote Waldameise und ihre Vermehrung ausführlich dargestellt. Nur soviel sei erwähnt, dass es 3 Hauptarten gibt, eine Grosse, Mittlere und Kleine Rote Waldameise. Dabei übertrifft speziell die Kleine Rote Waldameise alle bisher in den Nutzen der Roten Waldameise gesetzten Hoffnungen. Gerade diese Kleine Rote Waldameise ist mit einer Kiefern- und Fichtenrasse in den am meisten insektengefährdeten Nadelholzreinbeständen zu Hause, während die Mittlere Rote Waldameise in Übergangsgebieten verbreitet ist und die Grosse Rote Waldameise Laubwald, besonders Eichenbestände bevorzugt.

Auf eine natürliche Wiederansiedlung der Roten Waldameise kann nach der unnatürlichen Ausrottung durch den Menschen nicht gerechnet werden. Denn die jungen Weibchen der Grossen Roten Waldameise müssen sich bei einer nahe verwandten Wirtsameisenart adoptieren lassen, die zumeist fehlt. Die Kolonien der Kleinen Roten Waldameise vermehren sich durch Aufteilung. Wo kein Stamm-Nest vorhanden ist, kann keine Aufteilung stattfinden. Also bleibt die künstliche Vermehrung, die sich an den natürlichen Vorgang der

Schwarmbildung anlehnt. Volkreiche Kolonien können in einem Jahr 10 neue Nester aus sich hervorgehen lassen, wobei jedes Nest durch Abwanderung an einen 10 bis 100 m entfernten Baumstrunk ca 100000 Arbeiterinnen und mehrere hundert Königinnen mit Brut mitbekommt, so dass in Kürze ein vollwertiges Nest sich heranbildet. In gleicher Weise kann man Ableger zusammenstellen, indem eine grössere Anzahl von Arbeiterinnen einem Stamm-Nest entnommen werden. Dieser Ableger kann gleich eine Anzahl alter Königinnen aus dem Stamm-Nest mitbekommen, was nur zeitig im Frühjahr möglich ist, wenn sich die Königinnen während oder kurz nach der Sonnungsperiode auf dem Nest oder wenigstens in der Nestkuppel aufhalten. Später sind die Königinnen tief unten, 1-2 m tief im Boden. Dann setzt man weisellose Ableger aus und gibt aus der Königinnenmassenzucht einige hundert junge Königinnen nach allmählicher Geruchsangleichung zu.

Erst die Königinnenzucht, die auf die zu vielen Tausenden aus jedem Nest im Frühjahr ausschwärmenden jungen Männchen und Weibchen zurückgreift, ermöglicht eine schnelle Kolonievermehrung; denn erstens werden auf diese Weise die alten Stammnester geschont, sie behalten ihre eigenen Königinnen und zweitens werden die vielen hunderttausende von jungen Weibchen, die im Freien nutzlos verloren gehen würden, in der geordneten Königinnenzucht erhalten zwecks Verwendung für die Wiederverbreitung der Roten Waldameise. In einem Frühjahr konnten 300000 junge Königinnen gezüchtet werden.

Bei der Durchführung der Kolonievermehrung müssen die Art- und Rassenunterschiede der Roten Waldameise nach folgenden Gesichtspunkten berücksichtigt werden. Erstens wird überwiegend die besonders nützliche Kleine Rote Waldameise vermehrt, gelegentlich die Mittlere, selten die Grosse Rote Waldameise. Zweitens müssen die Ameisen in ihrem natürlichen Verbreitungsgebiet vermehrt werden, also die Fichtenrasse der Kleinen Roten Waldameise in Fichtenwäldern und die Kiefernrasse in Kiefernwäldern usw. Drittens ist die Siedlungsdichte verschieden in Anpassung an die sehr unterschiedliche Verträglichkeit der einzelnen Waldameisenarten. Die Nester der Kleinen Roten Waldameise können im Abstand von 50 m, nach Belieben auch viel näher angelegt werden.

Durch Kolonievermehrungen ab 1938 sind bereits vom gleichen Jahr ab in einem bisher ameisen-freien Dauerschadgebiet sämtliche Kalamitäten unterdrückt worden sind, obwohl im Umkreis der Nester ausserhalb ihres Jagdgebietes wiederholt Kahlfrass stattgefunden hatte.

In den durch einfache Kolonieaufteilung vermehrten Ameisenbeständen war die Ameisenbevölkerung ohne weiteres Zutun nach 5 Jahren auf 500% des Ausgangsbestandes durch natürliche Weitervermehrung angestiegen, bei den Zusetzen junger Königinnen betrug in etwa 80 Ablegern der Zuwachs bereits im ersten Jahr 470% im Durchschnitt. Auf Grund dieser Ergebnisse dürfen wir hoffen, dass durch Wiederverbreitung der Roten Waldameise und durch ihren praktischen Schutz das Gleichgewicht in der Lebensgemeinschaft des Waldes wieder hergestellt wird.

Fangapparat zum automatischen Absammeln der geflügelten Geschlechtstiere. Aufstellung über einem Nest der Kleinen Roten Waldameise. Näheres zur Methode bei GÖSSWALD, Die Rote Waldameise im Dienste der Waldhygiene, Metta-Kinau-Verlag, Lüneburg, 1951.

DISCUSSION

Dr. **Wellenstein**: Die Ausführungen von Prof. Dr. GÖSSWALD kann ich durch neuere, noch nicht veröffentlichte Freilandversuche wie folgt bestätigen und ergänzen:

1.) Von Menschen nicht gestörte Nesterverbände der Roten Waldameise bleiben bei vorsichtiger Durchforstung mindestens 25 Jahre unverändert.

2.) Grosskahlschläge haben Totalvernichtung bzw. Abwandern in erreichbare Nachbarbestände zur Folge.

3.) Waldameisen finden künstlich ausgesetzte Raupenansammlungen spätestens im halbwüchsigen Stadium, also vor Einsetzen des vernichtenden Raupenfrasses.

4.) Kleine Nester (6 m Umfang) haben in Beständen mit normaler Biozönose ein Aktionsgebiet von 0,5 ha, sie verbrauchen in der Vegetationszeit 220 Liter Blattlauszucker und 8 Millionen Insekten, davon 400.000 Forstschädlinge.

5.) In Massenvermehrungsgebieten von Raupen engt sich der Jagdbereich eines Nestes auf 0,1 - 0,2 ha ein.

SOBRE EL DESARROLLO Y COMBATE EN ESPAÑA DE LA LIPARIS MONACHA, EN MASAS DE PINUS SILVESTRIS DE LAS CORDILLERAS DE LA MESETA CENTRAL

por

G. CEBALLOS & E.ZARCO

Madrid, España

Durante los años 1950-51, la población de *Liparis monacha* en las masas de Pinus silvestris del Centro de España ha sufrido un desarrollo rápido e inusitado, alcanzando en extensión una cifra superior a 20.000 ha.

Con este motivo desde hace un año hemos llevado a cabo una serie de trabajos preparatorios de localización, estudio y ensayos de combate, con vistas a una resolución total del problema; experiencias aún inconclusas, pero que creemos interesantes, consideradas la topografía y características climáticas de los bosques españoles, dar a conocer sumariamente en la presente nota.

La plaga, por término medio, ha alcanzado alturas entre los 1000 y 2000 m, manifestándose sobre masas de P. silvestris. En masas de esta especie mezcladas con P. pinaster, se ven algunos árboles atacados, pero, en general, rodales de gran extensión de pinaster separando dos zonas de silvestris han servido hasta ahora de contención en el desarrollo de la calamidad de una a otra zona.

La puesta ha alcanzado las siguientes características:

Altura en el árbol	*Máx. de huevos por árbol*	*Mín. de huevos por árbol*
Entre 0 y 6 m	29.300	2.300

El desarrollo y duración de los distintos estados ha sufrido también considerables variaciones, según la altitud y orientación.

Las medias de temperatura registradas durante un año en una zona situada a 1100 m de altura han dado los siguientes valores:

Julio	1950:	Media	máxima:	28,3	Media	mínima:	8,3
Agosto	"	"	"	28,1	"	"	3,1
Septiembre	"	"	"	23,1	"	"	1,9
Octubre	"	"	"	17,4	"	"	-0,7
Noviembre	"	"	"	10,8	"	"	0
Diciembre	"	"	"	-0,8	"	"	-0,2
Enero	1951:	"	"	3,1	"	"	-2
Febrero	"	"	"	4,6	"	"	-3
Marzo	"	"	"	9	"	"	-0,2
Abril	"	"	"	10,4	"	"	0,04
Mayo	"	"	"	11	"	"	2,3
Junio	"	"	"	19,4	"	"	10,3

En esta misma zona, con alturas variando entre 1100 y 1250 m, el dearrollo embrional osciló de 20 a 30 días, comprendidos entre el 12 de Agosto y el 11 de Septiembre de 1950.

Las orugas comenzaron a salir del huevo el 4 de Mayo de 1951, observándose la formación de la primera crisálida el 12 de Julio del mismo año. Las orugas crisalidaron en su totalidad el 28 de Julio, lo que supone un período de duración máxima de este estado correspondiente a 85 días.

Datos correspondientes al vuelo del adulto durante el año 1951, no han sido aún ultimados.

En la Sierra de Urbión (Prov. de Soria) se ha llevado a cabo un ensayo de tratamiento en gran escala por avión en una zona correspondiente a un rectángulo, cuya base, en dirección Este-Oeste, medía 1256 m, y cuya altura, en dirección Norte-Sur, alcanzaba una longitud de 3000 m, lo que representa una superficie de 375 ha. Esta zona fué dividida en dirección Este-Oeste en 12 cuarteles de 1250 m de largo por 250 m de ancho. El conjunto de la zona comprendía alturas entre los 1160 a 1230 m, con desniveles máximos de 10 %, y fué señalada en sus cuatro ángulos por banderas permanentes, blancas y rojas, izadas en la copa de los pinos. Banderas blancas más pequeñas fueron utilizadas cada día, junto con humo, para señalar el cuartel a tratar.

En cada uno de los 12 cuarteles y con el fin de comprobar el volumen de excrementos, como índice de la comida de la oruga, se colacaron debajo de los árboles más intensamente atacados, lonas de 250 x 80 cm, levantadas del suelo unos 25 cm. Así mismo en una zona testigo, que no fué tratada, se colocaron lonas de las mismas características. Las mediciones de excrementos fueron realizadas diariamente.

El campo de aterrizaje, junto con el depósito de productos, se situó en Burgos, a 70 km aproximadamente en línea de aire del pinar.

Con el fin de mantener comunicación constante con el aeródromo y con el avión, se instaló en un raso del pinar un coche-radio. Esto permitió mantener una información constante de la situación atmosférica y rectificar repitiendo los vuelos defectuosos.

Como avión, se utilizó un aparato-trimotor „Junkers", puesto a nuestra disposición por el Ministerio del Aire, al que se adaptó un aparato distribuidor de emulsiones y suspensiones ideado por nosotros y construido por el Instituto de Técnica Aeronáutica.

El aparato distribuidor de insecticida estaba provisto de 4 depósitos con una capacidad de 2000 litros, llevando a todo lo largo de las alas una barra pulverizadora. Un molinete de 4 aspas, accionando el eje de una bomba centrífuga, llevaba el líquido de los depósitos a las barras. Una desviación en el tubo de salida de la bomba permitía mediante una llave, volver el líquido de nuevo al depósito, siendo allí vertido de nuevo a través de múltiples orificios de tubos interiores, como sistema de agitación, en vuelo.

La velocidad de pasada del avión fué de 3330 m por minuto a una altura media de 6 m (altura máxima: 15 m, alt. mínima: 4 m).

Como productos se emplearon:

Emulsión de Hexaclorociclohexano al 50% con 6% de isómero gamma.

Polvos de Hexaclorociclohexano para suspensión en agua al 25% de producto puro, con 18% de isómero gamma.

Polvos DDT para suspensión en agua al 20% de producto puro.

Polvos DDT para suspensión en agua al 50% de producto puro.

Las cantidades de producto puro que de estas insecticidas fueron distribuidas por ha son:

Emulsión de Hexaclorociclohexano	3 kg
Polvos de Hexaclorociclohexano	3 »
Polvos DDT 20%	2,5 »
Polvos DDT 50%	2,5 »

Se llevaron a cabo un total de 26 vuelos en 15 días, comprendidos entre el 6 de Junio y el 7 de Julio de 1951. Las lluvias y tormentas durante esta época dificultaron mucho los vuelos.

Los resultados del tratamiento han puesto de manifiesto una mortandad global del insecto en toda la zona equivalente a un 80%, deduciéndose además:

a) mayor permanencia del efecto letal del DDT, principalmente después de la lluvia.

b) rápido efecto letal del Hexaclorociclohexano en las primeras 48 horas.

c) mayor economía de la suspensión de polvos de Hexaclorociclohexano.

d) necesidad de un mayor número de vuelos para repartir la concentración necesaria en las suspensiones.

Summary

In connection with an extraordinary multiplication of *Liparis monacha* on Pinus silvestris in the woods of Central Spain, extensive studies have been initiated for its control, directed by the Entomological Institute of Madrid. Dusting from airplane was carried out during a fortnight; the experimental area, covering 375 ha, being situated in the Sierra de Urbión (Prov. Soria). The type of airplane chosen was a three-engined "Junkers" fitted with an especially constructed dusting apparatus and carrying containers with a capacity for 2000 liters. Emulsions and powders of HCH, and DDT of 20 and 50% were used. The result obtained was an 80% mortality of the caterpillars.

During the preparatory work a thorough search for and counting of egg-clusters of *Liparis* on the trees were made and temperature averages were calculated in the experimental area. At the time the dusting was carried out the larval excrements were collected on sheets beneath the infested trees and counted. Both flags and fires showed the pilot where to put down the dust. An ambulant radiostation facilitated the constant communication between the entomologists, the pilot, and the airport.

EIN ZEDERNSCHÄDLING: ACALLA UNDULANA Wlsghm.

von

Abdulgafur ACATAY

Büyükdere, Türkei

Im Jahre 1944 wurde ich darauf aufmerksam gemacht, dass die Zedern (*Cedrus libani* Barr.) in den verschiedenen Gebieten von Vilayet Antalya (im Süden Anatoliens) in grossen Massen Kahlfrass aufwiesen. In den folgenden Jahren, besonders im Jahre 1945 und 1946 bemühte ich mich um die Feststellung des Schädlings, seiner Lebensweise und Verbreitung.

Die Zeder tritt in Südanatolien und zwar im Taurus und Antitaurus auf (s. Abb. 1). Die Zedernbestände befinden sich in Höhenlagen von 1000 bis 2000 m *).

Bei den im Jahre 1945 vorgenommenen Untersuchungen der Zedernbestände im Tülek – Walde bei Antalya auf einer Seehöhe von 1470 m. wurde festgestellt, dass die Ursache der Kalamität Raupen eines Kleinschmetterlings waren. Die aus diesen Raupen erhaltenen Schmetterlinge wurden durch Prof.Dr. E. SCHIMITSCHEK (Wien) als *Acalla undulana* Wlsghm. bestimmt. Ich danke Prof. SCHIMITSCHEK an dieser Stelle für die Übermittlung der Bestimmung.

Der Falter dieser variablen Art hat eine Spannweite von 9-11 mm, die Vorderflügel sind bräunlichgrau, die Hinterflügel hellbraun mit Fransen (s. Abb. 2).

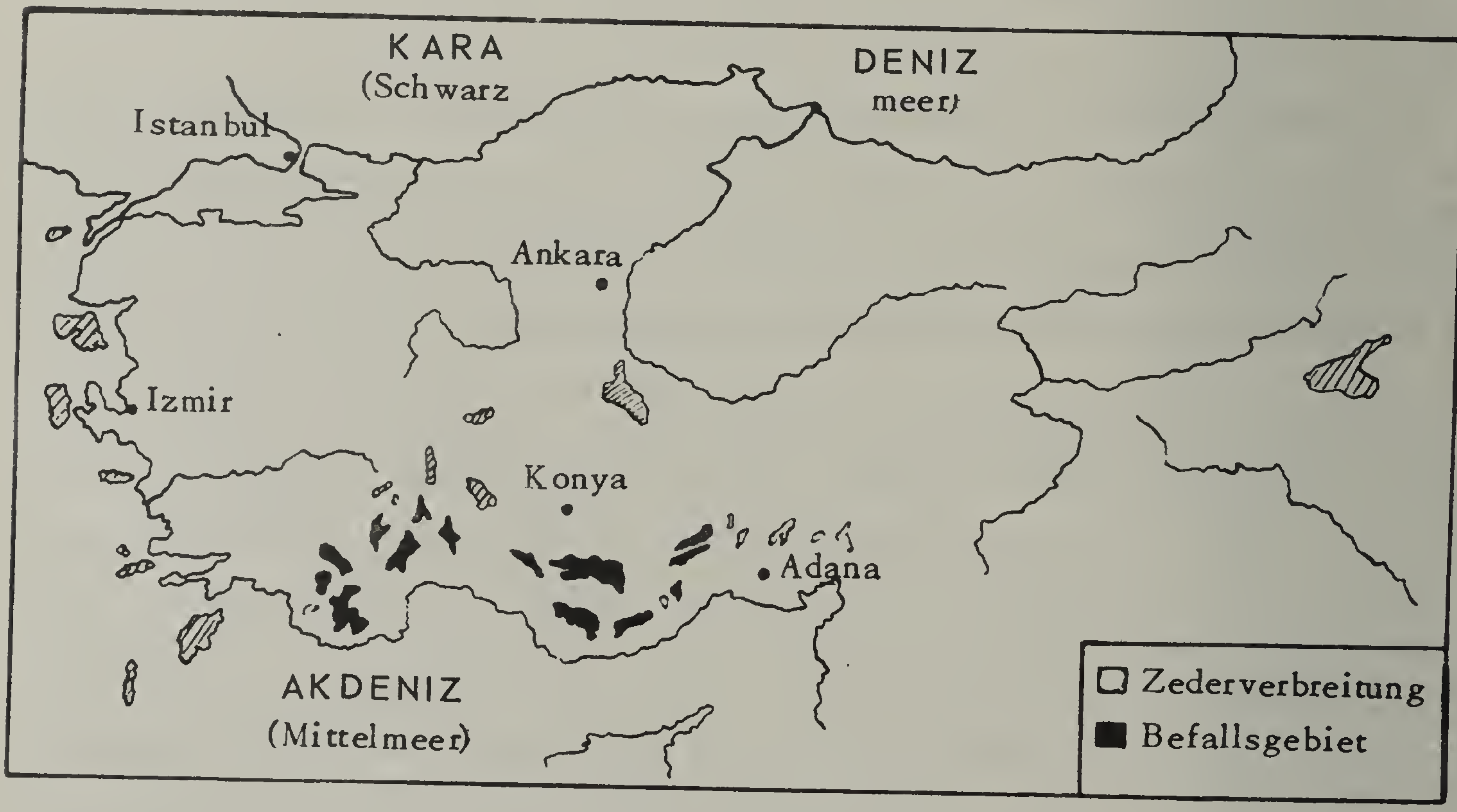


Abb. 1.

*) E.SCHIMITSCHEK, Forstinsekten der Türkei und ihre Umwelt: S. 10, 1944.

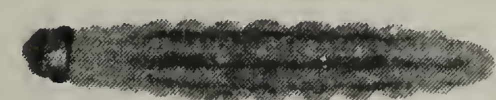
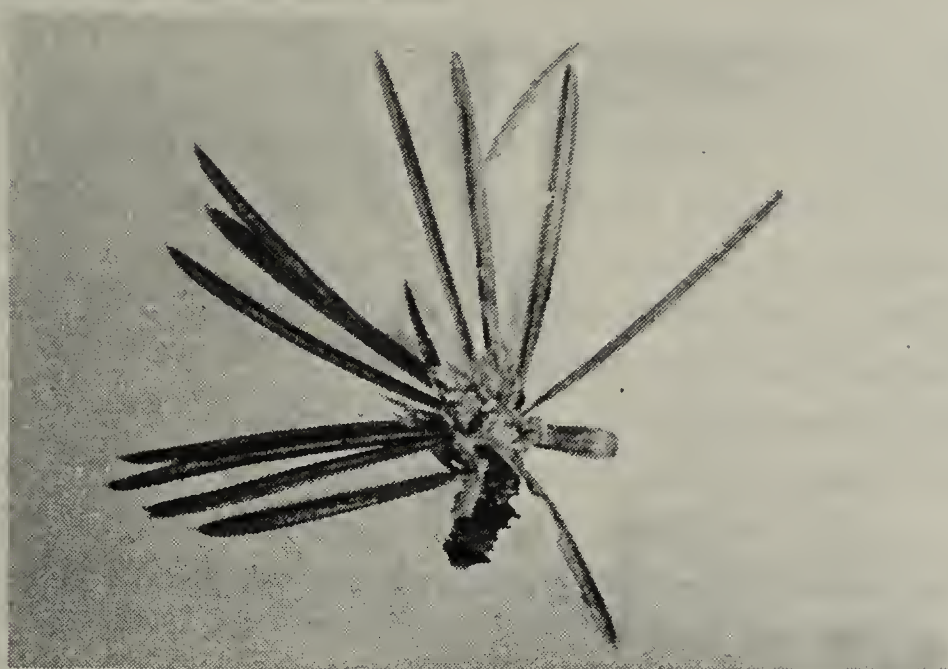
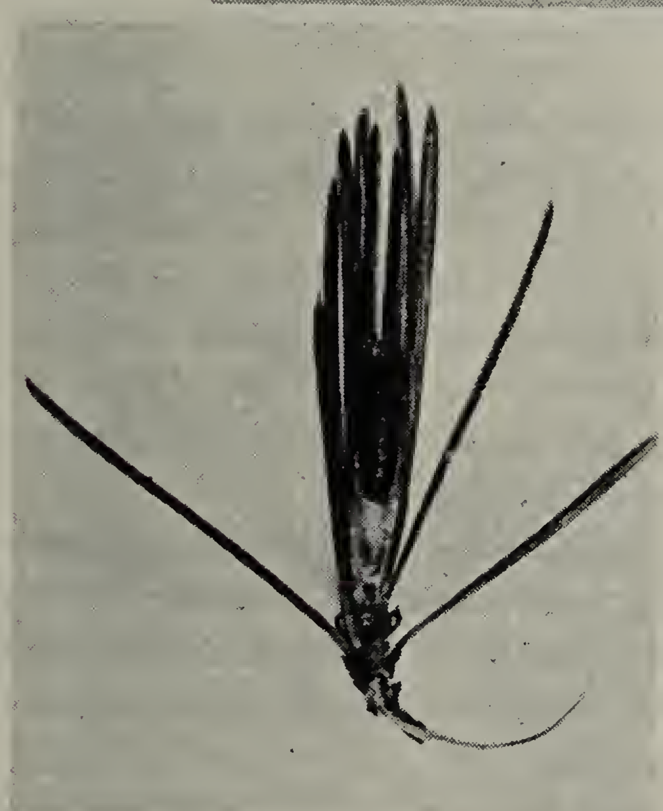
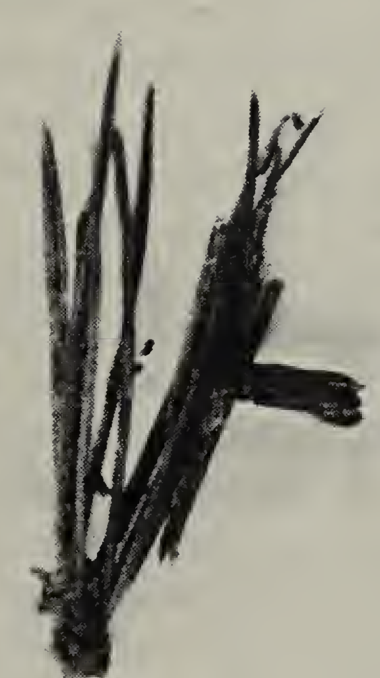


Abb.
2-6.







Die bis 11 mm lange Raupe ist auch variabel. Ihr Kopf und Nacken ist hellbraun bis schwarzbraun. Der Körper ist hellgrün oder gelb, zerstreut behaart. Auf dem Rücken befinden sich mehr oder weniger deutlich 3 Längsstreifen (s. Abb. 3). Die dunkle Kopffarbe ist meist bei kleinen Raupen zu beobachten; bei manchen Exemplaren sind die Wangen länglich getüpfelt.

Die Raupen waren am 8.6.1945 ca. 4 mm lang und befanden sich in der Mitte der im Anfang ihrer Entfaltung befindlichen Kurztriebe, teils frei, teils in einem sackähnlichen Gespinst, bestehend aus Fäden und Nadeln.

In den Kurztrieben leben die Raupen meist einzeln, selten zu zweit. Sie wechseln ihre Plätze und Gespinste von Zeit zu Zeit. In der Kurztriebmitte liegen daher Gespinste ohne Raupen. Die Räupchen benagen anfangs ganz junge Nadeln an der Spitze oder seitlich. Die Spitzen der beschädigten Nadeln werden mit der Zeit fahl und trocken. Die Raupen verlassen die Triebe ohne sie ganz aufzufressen und gehen an neue junge Triebe; in späterem Stadium, besonders in der Not, gehen sie auch auf die vorjährigen Nadeln über. So entsteht ein Kahlfrass. Er kommt aber auch durch hintereinander folgenden Raupenfrass auf einem Baum zustande. An den Frassstellen sind sehr geringe Mengen Raupenkot zu beobachten.

Die Räupchen sind lichtscheu und sehr beweglich. Bei Gefahr lassen sie sich an einem Gespinstfaden herab.

An verschiedenen Stellen des Waldes beobachtete ich, dass die oberen Teile der Krone von den Schmetterlingen bevorzugt werden. Es ist sehr wahrscheinlich, dass die Weibchen ihre Eier gern in den oberen Kronenteilen ablegen, die Raupen mit ihren Gespinstfäden auf die unteren Äste herabkommen und dadurch ein von mir beobachteter Fädenschleier entsteht.

Acalla undulana Frass wurde hauptsächlich an den Stangenhölzern und Bäumen, selten an jungen Pflanzen beobachtet.

Am 16. Juni 1945 waren die Räupchen zum Teil vollwüchsig. Die Verpuppung begann im Laboratorium am 18.6.1945. Im Durchschnitt währte die Puppenruhe dieses Schädlings 9-12 Tage. Die ersten Schmetterlinge erschienen am 28.6. und die letzten am 7.Juli. Demnach fällt die Flugzeit in die Zeit um Ende Juni und in den Monat Juli. Die Verpuppung erfolgt an den Frassstellen (s. Abb. 4, 5 und 6).

Die Befallsdichte war an manchen Stellen des Waldes ausserordentlich gross und die Bäume waren vollkommen kahl gefressen.

Da ich nicht ununterbrochen die Entwicklung des Schädlings im Walde verfolgen konnte, war es nicht möglich, Beobachtungen über die Eiablage zu machen. Die Schmetterlinge im Laboratorium legten in ihrem Zuchtkäfig keine Eier ab, obwohl ihnen Zedernpflanzen, Bespritzung mit Zuckerlösung und verschiedene Blumen zur Verfügung standen.

Die Entwicklungsdauer beträgt in den hiesigen Beobachtungsgebieten, die im Bereiche des Mittelmeerküstenklimas in einer Höhe von 1450 m liegen, in der Regel ein Jahr.

Die forstliche Bedeutung: *Acalla undulana* tritt in den meisten Verbreitungsgebieten der Zeder in Anatolien (s. Abb. 1) auf. Sie ist imstande in Massen aufzutreten und die Zedernbäume kahl zu fressen. Im Jahre 1945 war das Schadengebiet ca. 1200 ha gross. In den folgenden Jahren vergrösserte sich die Kalamität. Heute bedroht diese Gefahr alle Zedernbestände in verschiedenem Masse. Da die Zeder gegen die Beschädigungen widerstandsfähig ist, hält sie dieselben vorläufig noch gut aus.

IMPORTANCE DES DÉGÂTS DE LA MINEUSE DU CAMBIUM DU PEUPLIER POUR L'INDUSTRIE DU DÉROULAGE

par
Robert RÉGNIER
Rouen, France

La fabrication des boîtes à fromages

Pour le logement et le transport des fromages fermentés, les fabricants français utilisent généralement du bois de peuplier; celui-ci est léger, ne communique pas d'odeur comme les résineux, ne nuit pas à l'affinage et se déroule facilement.

Le développement de la production fromagère, qui a doublé depuis la guerre, pose un problème d'approvisionnement en bois de peuplier, exempt de défauts. Or quand on saura que la seule fabrication du Camembert, exige en Basse-Normandie la confection de 800.000 boîtes par jour, on aura une idée de l'importance de la question.

Arrivées à l'usine les grumes sont tronçonnées, avant écorçage, à la scie électrique en billes de deux longueurs différentes:

a) Billes de 65 centimètres, destinées au déroulage à 20 dixièmes pour faire les fonds des boîtes, et éventuellement du contre-plaqué;

b) Billes de 44-45 cm, destinées au déroulage à 8 dixièmes pour faire les „copeaux" qui servent au tour des boîtes.

Les billes passent à l'écorcage aussitôt après le tronçonnage, puis à la dérouleuse.

Le bois de peuplier contenant 50 à 60 pour cent d'eau par rapport à la matière sèche, les feuilles de déroulage, après un contrôle rapide de leur état, vont au séchoir:

Les belles feuilles réservées au contreplaqué sont séchées à 10 pour cent. Les feuilles déroulées à 20 dixièmes sont séchées à 20 pour cent. Les feuilles déroulées à 8 dixièmes sont séchées à 35 pour cent, ce qui permet aux copeaux qui en seront tirés de garder une grande souplesse.

En raison de la faible épaisseur des copeaux, les moindres défauts du bois risquent de provoquer des cassures, qui obligent à les rejeter. Le rendement journalier d'une bonne équipe de façonneuses de boîtes étant de plus de 20.000 par jour, on se rend compte des pertes qui peuvent résulter d'une mauvaise qualité des copeaux, qui leur sont livrés.

Les dégâts de la mineuse du cambium.

Parmi les défauts – bienque souvent peu apparents – il convient de signaler les galeries creusées par les larves d'un diptère de petite taille, appartenant à la famille des *Agromyzidae* qui minent l'aubier et le cambium de l'arbre en végétation sans lui causer de dommage appréciable, et dont on retrouve les traces successives dans les différentes couches du bois, lorsqu'on le passe à la dérouleuse.

Les galeries ont de 0.5 à 2 millimètres de large, sont aplaties par la croissance de l'arbre, et forment tantôt de simples sillons, à peine visibles, tantôt des taches médullaires plus ou moins teintées de brun très apparentes.

L'insecte paraît abondant surtout dans les régions marécageuses et s'attaquer aux arbres dans les douze premières années; on en trouve les traces jusqu'à 16 et 18 mètres de haut. Dans certains lots la perte des copeaux peut être de l'ordre de 50 pour cent.

La détection des foyers est extrêmement délicate; ce n'est guère qu'au moment du déroulage que l'on s'en aperçoit, tout au moins dans les billes de pied; nous avons pu les repérer par contre, après écorcage, sur les billes de centre ou de tête, au-delà de cinq mètres.

Les arbres attaqués ont une apparence saine; rien ne permet extérieurement de déceler les attaques; ce n'est qu'en mettant à nu le cambium des arbres relativement jeunes que l'on peut s'en rendre compte. Ce contrôle, comme on peut le penser, n'est pas sans inconvénient pour l'avenir de l'arbre choisi.

La mineuse du cambium et son développement.

N'ayant jamais réussi jusqu'ici à élever la larve, nous ne pouvons faire que des présomptions sur son identité et son développement, mais d'après ce que nous avons pu observer, tout nous met en droit de penser qu'il s'agit d'une espèce voisine de *Dizygomyza*(*Dendromyza*) mouche mineuse du cambium des saules, étudiée en 1935 en Autriche par E.SCHIMITSCHEK (1)qui a signalé des dégâts du même ordre dans les anneaux annuels des tiges de peupliers.

La question des taches médullaires d'origine entomologique dans le bois n'est d'ailleurs pas nouvelle: elle a été étudiée dès 1883 par KIENITZ (2), reprise par NIELSEN (3) en Allemagne vers 1906, puis par BROWN (4) aux Etats-Unis et par C.T.GREENE (5) en 1914 et 1917, mettant en évidence le rôle des *Agromyza* comme larves mineuses du cambium du bouleau, de l'érable rouge et du sorbier. Les travaux de KANGAS (6) en Finlande ont confirmé le rôle de ces diptères dans le cambium des bouleaux, des trembles et des saules; plusieurs espèces appartenant au sous-genre *Dendromyza*, ayant une biologie similaire, interviendraient.

D'après les recoupements que nous avons pu faire, la ponte doit avoir lieu dans le courant de juin, les larves creusent dans la couche cambiale de longues galeries, qui s'entrecroisent. Arrivées au terme de leur développement, vers le mois d'août, peut-être même en juillet, elles se nymphosent dans le sol au pied des arbres; les mouches ne sortiront qu'au milieu du printemps suivant. Il ne paraît y avoir qu'une génération par an.

Moyens de lutte et méthode de contrôle.

La difficulté de détection précise des foyers rend très problématique l'application efficace de moyens de lutte. En raison de la sensibilité des dip-

tères à l'hexachlorocyclohexane, l'incorporation au sol de ce produit au pied des arbres présumés attaqués, avant la descente des larves, nous paraît indiquée, mais étant donné le peu d'intérêt que présentent les attaques pour les planteurs, nous doutons fort que des mesures soient appliquées.

Reste la méthode de contrôle des billes attaquées à l'usine. Elle nous semble parfaitement applicable, en réservant au petit déroulage les billes reconnues indemnes à l'écorcage. En général l'attaque est localisée sur des lots bien déterminés; il y a donc de fortes présomptions pour que les dégâts que l'on repère sur un arbre du lot se retrouvent chez les autres. Comme d'autre part normalement les billes de pied, jusqu'à 3 et 4 mètres, sont peu ou pas attaquées, on peut faire *a priori* un premier classement.

L'erreur des usiniers est, à mon avis, de faire tronçonner immédiatement les grumes à 44-45 cm pour dérouler à 8 dixièmes, sans savoir si le bois est absolument sain. En tronçonnant les grumes suspectes à 135 cm et en procédant ensuite à l'écorçage de ces billes, on aurait la possibilité de les diviser en trois billes de 44-45 pour faire des copeaux, si le bois est sans défaut, apparemment du moins; ou en deux billes de 64-65 pour du déroulage à 20 dixièmes si l'on constate des galeries à l'écorçage. Reste une inconnue, c'est la présence possible de galeries en profondeur, notamment dans les billes de pied.

Ce contrôle ne complique pas sensiblement les opérations, et il est en tout cas moins onéreux que la perte de milliers de copeaux au moment de la fabrication des boîtes.

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Note. - Nous reçevrons volontiers toutes informations utiles relatives à l'importance de la mineuse du cambium sur peupliers en d'autres pays.

Summary

The use of poplar for the manufacture of cheese boxes is steadily increasing in France; in Low Normandy the production of such boxes is now over 800 000 a day. Wood of very good quality without any defect is required, especially for the making of the encircling bands of the boxes for which "shavings" of only 0.8 mm thickness and 40-50 cm length are used. Therefore the slightest weakness in the wood causes ruptures which render the material useless.

Particularly troublesome in this respect are traces left by the larva of a very small dipteron, belonging to the family Agromyzidae, boring in the cambium zone; old tunnels are to be found in the outer layers of the logs.

The injuries caused by Agromyzid larvae have been known for a long time as occurring in Salix, Betula, Sorbus, Acer and occasionally in Populus, in Europe as well as in North America, but so far they have not been of such economic importance.

The insect has not yet been identified; the author believes it is related to *Dendromyza(Dizygomyza)* which damages basket willows in Austria.

In some plantations the injuries are found in more than 50% of the trees; they can only be detected when the wood layers are exposed.

Heavy losses may be prevented by investigating the bark of the logs before they are cut to fit in the machine. If mines are detected the logs have to be used for making veneer of a greater thickness.

The control of the insect in the plantations appears to be difficult but it might be possible to treat the soil at the base of the trees, where pupation probably takes place, with an insecticide containing benzene-hexachloride.

The author would like to receive information from colleagues concerning this problem, especially as regards the detection of the breeding places and the method of rearing the insect under controlled conditions.

AUFTRETEN UND BEKÄMPFUNG DES HAUSBOCKS

von
Otto HESPELER
Lübeck, Deutschland
(mit Film)

Ich hatte schon auf dem Kongress in Stockholm Gelegenheit, über die Lebensweise des Hausbocks (*Hylotrupes bajulus*) zu sprechen, und Herr Dr. BECKER hat in Sektion IX über den wissenschaftlichen Stand der Bekämpfungsmittel berichtet, sodass ich mich heute auf die derzeitige Verbreitung in Deutschland und auf die sich daraus entwickelnde Gefahr beschränken kann. Daran anschliessend möchte ich Ihnen einen Film zeigen, und dabei noch etwas auf einige praktische Fragen eingehen.

Vor etwa fünfundzwanzig Jahren war der Hausbock in Deutschland eine sehr seltene Angelegenheit, man fand ihn nur vereinzelt, und als ich immer wieder auf seine Gefährlichkeit hinwies, glaubte man mir nicht so recht. Als man aber zwischen 1927 und 1935 nahere Untersuchungen anstellte, und besonders, als in Hamburg und Lübeck eine öffentliche Versicherung einsetzte und in Schleswig-Holstein die Landesbrandkasse die Bekämpfungsarbeiten geldlich unterstützte, wurden immer mehr Fälle gemeldet. Dann wurde man auch in anderen deutschen Ländern auf die Sache aufmerksam, und fast überall wurden mehr oder weniger grosse Schäden festgestellt. Überall setzte die Bekämpfung und Vorbeugung ein, zahlreiche Bekämpfungsmittel wurden entwickelt, und in wissenschaftlichen Instituten wurden Lebens- und Bekämpfungsweise studiert. Aber der Krieg brachte fast alle diese Massnahmen zum Stillstand, und als man 1948/49 wieder an die Sache heranging, wurde mit Schrecken festgestellt, dass sich dieser Schädling ausserordentlich stark weiterverbreitet hat. Dass die Schäden, die jetzt entdeckt würden, meist ihren Ursprung in der Zeit nach der Aufdeckung der ersten Fälle hatten, ist bei älteren Häusern an der Art der Schäden zu ersehen, wird aber besonders dadurch bewiesen, dass jetzt an vielen Häusern, die erst nach 1926 neu gebaut wurden, Hausbockvorkommen, ja teilweise stärkste Zerstörungen festzustellen sind. Ich bearbeite zur Zeit Häuser dieses Alters, bei denen das Dachgeschoss und zwei Balkenlagen völlig abzubrechen sind. Der Befall bei neueren Gebäuden, also auch bei obengenannten, ist deshalb so gefährlich, weil die Hölzer dort im Gegensatz zu alten Bauten statisch scharf errechnet sind, und daher schon die Zerstörung der Aussenflächen die Tragfähigkeit beeinträchtigen. Besonders gefährlich ist ein Angriff in den Balkenlagen unter dem Holzfussboden, da man dort das Auftreten nicht sieht und schwer bekämpfen kann. In vielen dieser Häuser ist auch das Dachgeschoss ausgebaut, das heisst, die Sparren sind immer verschalt und verputzt, sodass man auch dort mit der Bekämpfung nicht oder nur schwer

an das Holz herankommt, ohne die ganze Verschalung mit Putz wegzunehmen.

Wir finden aber den Hausbock in Häusern jeden Alters. Doch sind ältere harte Hölzer nicht so oft angegriffen wie das Holz neuerer Häuser, das frisch geschlagen und nicht, wie früher, geflösst wurde. (Die Auslaugung durch das Wasser scheint wichtige Nährstoffe dem Holz entzogen zu haben und es dadurch dem Hausbock nicht mehr begehrenswert zu machen.)

Die Entwicklungsdauer der Larven ist verschieden, in der Nähe von warmen Schornsteinen, an Stellen mit viel Sonnenbestrahlung entwickeln sich die Larven rascher als an kälteren Orten. Die Larve ist sehr widerstandsfähig gegen Kälte und überdauert selbst den stärksten Winter, allerdings ist dann ihre Frasstätigkeit sehr eingeschränkt. In Deutschland ist das Küstengebiet mit seiner feuchteren Luft mehr vom Hausbock heimgesucht als andere Landesteile, aber er findet sich auch an Orten, mehr oder weniger stark, im Osten, Westen und Süden. Und überall ist eine zunehmende Entwicklung zu erkennen.

Eine kleine Rechnung zeigt hier die Vermehrungsmöglichkeiten: Wenn zum Beispiel im Jahre 1943 ein einziger Käfer eingeflogen ist und 50 Eier legte, so würden sich aus diesen im Jahre 1949 schon etwa 950 Eier entwickelt haben. Ist dazu im Jahre 1944 auch nur ein weiterer Käfer zugeflogen, so sind 1950 rund weitere 950 Larven da. Fliegt 1945 auch wieder nur ein einziger Käfer ein, so fressen 1951 aus diesen drei Stammkäfern schon etwa 2850 Larven. Diese können, wenn sie ihr Lebensende erreicht haben, schon eine recht stattliche Zerstörung angerichtet haben und sich – wenn nichts dagegen unternommen wird – so gewaltig vermehren, dass Larvenzahl und damit Zerstörungen geradezu lawinenhaft anwachsen.

Hieraus können folgende Schlüsse gezogen werden:

1.) Je früher der Schädling im Anfang seines Auftretens bekämpft wird, desto eher kann man seine Ausbreitung verhindern.
2.) Wenn irgend möglich, sollte man das Bauholz durch Eisen oder Eisenbeton ersetzen.
3.) Wenn man aber Holz verwendet, sollte man es vor dem Einbau, besonders an Stellen, an die man später nicht mehr herankommt, mit einem Vorbeugungsmittel behandeln und diese Behandlung bei den erreichbaren Holzteilen wiederholen, wenn das Holz beim Trocknen die unvermeidlichen Risse erhalten hat.
4.) Das völlige Abschliessen von Holz durch Dachausbauten sollte so viel wie möglich vermieden werden.

Und nun zu der eigentlichen Bekämpfung. Wir haben die ersten Schädlinge durch Vergasung (Cyklon B) vernichtet und gute Erfolge gehabt. Diese Behandlungsart findet kaum noch statt. Der Hauptgrund ist die Notwendigkeit einer völligen Räumung der Wohnhäuser von Menschen, Haustieren, Betten etc. Sie ist aber in Sonderfällen zum Beispiel in hohen Kirchtürmen mit starken Hölzern auch heute noch manchmal das einzige Mittel, um eine

völlig sichere Abtötung der tief im Holz sitzenden Larven zu erreichen.
Die in Dänemark mit so gutem Erfolg durchgeführte Heissluftbehandlung ist in Deutschland nur selten, aber dann auch mit Erfolg angewandt worden.

Weitaus am meisten werden die chemischen Mittel angewandt. Die ersten Erfolge hatten wir dabei mit dem Chlornaphtalinpräparat Xylamon. Bei der fortschreitenden Bekämpfungsarbeit wurden sehr viele neue Mittel angeboten, aber deren Zahl ist praktisch sehr zusammengeschrumpft, als die amtliche Prüfung nach genau festgelegter Normung einsetzte. Diese hat von den öligen Mitteln insgesamt nur sechs Mittel anerkannt, und zwar ausser den Chlornaphtalinen auch ein Teerölerzeugnis. Von den Salzen ist nur eines als Bekämpfungsmittel amtlich anerkannt, während für die vorbeugende Behandlung neben diesen obengenannten noch einige weitere zugelassen sind. Bei der Anwendung der einzelnen Mittel ist besonders die Eindringungstiefe und die Dauer der Schutzwirkung zu beachten, ausserdem ist es ganz besonders wichtig, dass das betreffende Mittel auch in der Menge und Konzentration aufgetragen wird, mit der seine Eignung amtlich festgestellt wurde. Geschieht dies nicht, so ist die Behandlung ganz oder grösstenteils zwecklos. Am Besten sind die Mittel, die als Frass-, Berührungs- und Atemgift wirken.

Um die Wirksamkeit solcher Mittel festzustellen und laufend nachzuprüfen, sind genaue Prüfungsmethoden vorgeschrieben, die wiederum das Vorhandensein von Versuchstieren voraussetzten. Da diese nicht immer aus dem befallenen Holz für die Erzeugerfirmen greifbar sind, haben die wichtigsten dieser Firmen eigene Laboratorien eingerichtet, in denen unter anderem auch Larven gezüchtet werden. Durch besondere Massnahmen, Brutschränke etc. hat man erreicht, dass man bei diesen Zuchtversuchen das Leben der Larven in einer mehr als zehnfach kürzeren Zeit als normal sich abspielen lassen kann. Dadurch hat man für alle Versuche über die Wirkung des Mittels als Frass-, Berührungs- und Atemgift immer genügend Larven zur Hand. Es ist selbstverständlich, dass dabei auch die Eindringungstiefen der Mittel in verschiedenen Holzarten und ihre Dauerwirkung geprüft wird.

Da der Hausbock ein ausserordentlich zähes Tier und daher seine Bekämpfung sehr schwer ist, andererseits aber die Zerstörungen dieses Holzschädlings immer grössere Formen annehmen, ist es besonders wichtig, dass durch solche eingehenden und laufenden Untersuchungen die zu seiner Bekämpfung und zur Vorbeugung gegen seinen Angriff verwendeten Mittel immer mehr verbessert werden.

Während bei Vergasung und Heissluftbehandlung einwandfrei die Tötung aller tief im Holz sitzenden Larven möglich ist, haben die mit Pinsel oder durch Spritzung aufgetragenen Mittel nur eine begrenzte Eindringungstiefe. Larven, die hinter dieser Zone sitzen, werden von dem Gift nicht berührt. Das Einbringen von Bekämpfungsflüssigkeit durch Bohrlöcher in die inner-

sten Schichten des Holzes ist recht teuer. Daher ist das Erreichen einer grösseren Tiefenwirkung durch einfaches Verfahren, das gleichzeitig einen hohen Vorbeugungsschutz gibt, ohne für Menschen und Tiere schädlich zu sein, und ohne Eisen anzugreifen, sehr wichtig. Die Forschungen in den Laboratorien dienen diesem Zweck.

Der Hausbock ist ein grosser Schädling des Volksvermögens. Er achtet keine Ländergrenzen. Es ist daher auch für Länder, in denen er bisher nur wenig auftritt, wichtig, sich mit ihm zu beschäftigen, da er wie in Deutschland sich in jedem anderen Lande in etwa 20-30 Jahren nach seinem ersten grösseren Auftreten zu einer grossen Gefahr für das Volksvermögen entwickeln kann.

THE INTER-RELATION OF INSECT ATTACK ON STORED FOOD AND ON WOOD

by

J. A. FREEMAN

Tolworth, Surrey, England

Introduction

Whilst most of the losses to stored food occur owing to attack on the food itself by insects (FREEMAN 1951), these and true wood boring insects may cause damage by attacking wooden boxes used for packing food, or by weakening the structure of food factories and warehouses. Food insects, migrating from food when fully-grown, may also damage the woodwork of food stores. Various examples of this kind of damage are given in this paper, based on the experience of the Infestation Control Division of the Ministry of Agriculture in England and Wales.

Damage to containers

(1) Damage caused by food pests

Wooden boxes containing food are not infrequently tunnelled by fully grown larvae of *Dermestes spp.*, which do so in order to establish secure places in which to pupate. Attack may occur from inside or outside. In one instance fully grown larvae of *Dermestes lardarius* Linn. which had bred in sausages packed in wooden boxes, damaged the cases by tunnelling into them. Where boxed goods are stowed in the same holds of a ship as other goods infested by Dermestids, attack may occur from outside. During July 1951 a large number of wooden boxes of South American canned meats was found, on arrival in the United Kingdom, to have been badly tunnelled by larvae of *Dermestes frischii* Klug. and *Dermestes maculatus* Deg., which had migrated from bones which had surrounded the boxes in the ship's hold. This consignment had to be fumigated before the boxes were removed for storage inland. Other exemples are given in FREEMAN (1950). There are very few insects which appear to be able to feed both on wood and on other plant products or on animal products. One of these is the Bostrichid beetle, *Dinoderus minutus* F., which not only bores in bamboo wood, but also in starchy roots and even in maize (FISHER 1950).

(2) Damage caused by wood boring insects

From time to time imported foods have been found by the Division packed in wooden cases, which have been so badly damaged by wood boring insects that it has been necessary to repack the contents or to fumigate the whole consignment to prevent further damage to the cases and to prevent spread of wood boring insects elsewhere. Examples of this type of damage include tea chests and cashew kernel crates from India attacked by *Heterobostrychus*

aequalis Waterh., *Minthia rugicollis* Walk. and *Sinoxylon conigerum* Gerst. and canned meat and canned butter cases from Australia damaged by *Lyctus brunneus* Steph. (FREEMAN 1950). During mid 1950 the willow wood boxes of a quantity of South American canned meat which had been in store in Southern England for two years, were found to be badly damaged by *Lyctus brunneus* (fig. 1). The whole parcel (1400 cases) was successfully fumigated with methyl bromide at 30 oz. per 1000 cu. ft. for 52 hours.

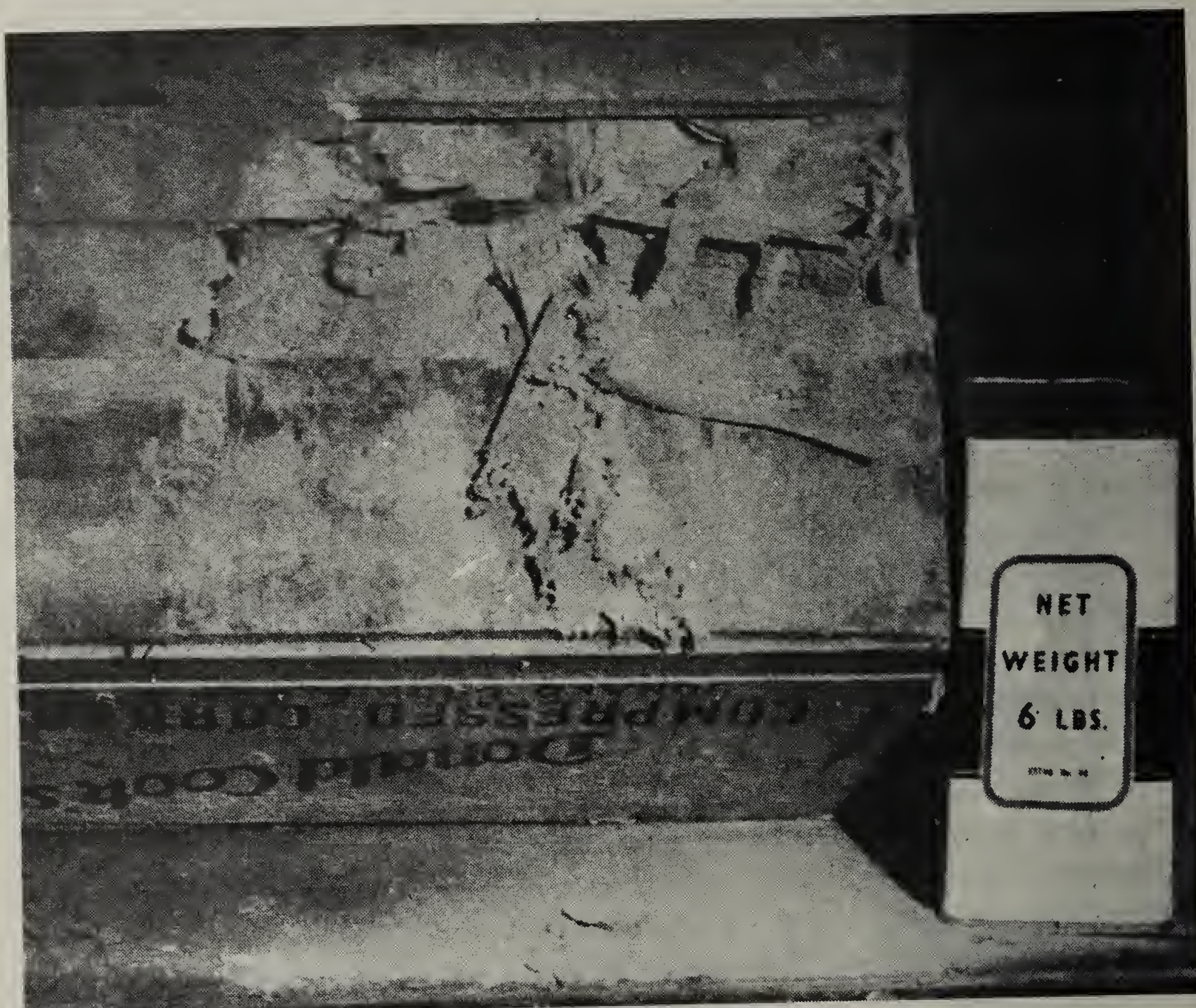

Fig. 1. Box of canned meat damaged by attack of *Lyctus brunneus* Steph. (Crown copyright reserved).

Apart from the risk of spread of wood boring beetles in food containers, there is the danger that the cases may be so weakened that the contents may flow out e.g. tea chests, or that tins may collapse and burst owing to pressure resulting from the breakage of the supporting boxes.

Damage to the woodwork of buildings

(1) Damage caused by food pests

The larvae of a number of food pests tend to leave the food when they are fully grown and tunnel into wood, hardboard, insulating board and other building materials, in finding suitable places for diapause or pupation. The habit

of certain *Dermestids* in tunnelling into boxes has already been mentioned. Insects which have been observed with such habits in warehouses in the United Kingdom include *Ptinus tectus* Boiel., *Dermestes lardarius* and *Tinaea infimella* H-S. In flour mills and grain warehouses the larvae of *Tenebroides mauritanicus* Linn. tunnel readily into minute cracks in the woodwork of grain bins and flour milling machinery; large numbers of larvae may often be found packed together tightly in such places. Adults of the beetles *Tribolium confusum* Duft, *Gnathocerus cornutus* Fab. and *Rhizopertha dominica* F., which normally live in milled products and in whole grain respectively, have been observed boring into the wooden floor of a flour mill. In fish meal and bone processing works it has been found necessary to replace wooden beams with steel girders owing to the severe structural damage done by the boring of the larvae of *Dermestes lardarius* and *Dermestes maculatus*.

Superficial damage to woodwork is done by the larvae of *Endrosis sarcitrella* Linn., which excavate small depressions in the wood over which they spin cocoons. Such slight damage to woodwork may not matter very much in a normal warehouse, so long as the structural strength of the store is not affected. When food has to be stored in all kinds of temporary buildings, as during the period 1939-1945 in the United Kingdom, damage to the woodwork of chapels, cinemas and private houses, is a serious matter, particularly to floors and panelling.

(2) Damage caused by wood boring insects

Where the structure of food warehouses or factories is seriously affected by the tunnelling of true wood boring insects such as *Anobium punctatum* Deg., there is risk of collapse of floors with waste of food or the warehouse may not be able to store as large a quantity as it should, owing to reduced rate of stacking on the weakened floors, thereby increasing the cost of storage. Although not of serious consequence to the structure, since they tend to breed in floor boards which are already rotten, the occurrence of the Curculionids *Pentarthrum huttoni* Woll., *Euophryum confine* Brown, and *E. rufum* Broun. (BUCK 1948) in food warehouses is of some interest since these beetles at first sight may be readily confused with the true grain weevil, *Calandra granaria* L., and unnecessary control measures may be taken on the basis of a misidentification.

One of the effects of the activity of insects in boring into the woodwork of warehouses is to provide harbourage for food pests, in which they can hide when the store is empty and where they are protected from insecticidal treatments or the effects of the weather. Large numbers of *Oryzaephilus surinamensis* Linn. and *Laemophloeus* spp. were found hiding in *Anobium* tunnels in the woodwork of grain bins in an East Anglian warehouse, after heavily infested barley had been removed.

Conclusion

Some examples are given of the damage caused to food by attacks of wood boring insects on boxes and the wooden structure of buildings. Such losses can be prevented in part by the use of non-susceptible timbers for box making and controlled by the fumigation of infested boxes to prevent further deterioration and the spread of pests. In warehouses normal methods of control of wood boring insects will prevent damage to structural timbers and thereby any loss of food from structural weakness or from harbourage of storage pests.

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HOLZSCHUTZ GEGEN INSEKTEN IN DEUTSCHLAND

von
Günther BECKER
Berlin-Dahlem, Deutschland

Auf dem 7. Internationalen Kongress für Entomologie 1938 in Berlin hatten mehrere Vorträge den Hausbockkäfer (*Hylotrupes bajulus* L.) als wichtigsten Holzschädling in vielen Ländern Europas und das Problem seiner Vernichtung und Fernhaltung behandelt. Als Bekämpfungsmittel standen damals Hitze, Blausäure, Steinkohlenteeröl-Präparate, die neuentwickelten chlorierten Naphtaline und Fluosilicat-Präparate im Vordergrund. Es war eine „Arbeitsgemeinschaft zur wissenschaftlichen Förderung der Hausbockkäferbekämpfung" gegründet worden, die die Prüfung und Anerkennung von Schutz- und Bekämpfungsmitteln in Deutschland übernahm. Sie bestand bis zum Kriegsende. Anobien und andere holzzerstörende Insekten waren zu dieser Zeit noch recht wenig beachtet. Die Kenntnis ökologischer Zusammenhange war sehr beschränkt, und über die Wirksamkeit der chemischen Präparate auf die Insekten und ihre sonstigen, besonders die technologischen Eigenschaften begann man erst Erfahrungen zu sammeln.

In der Zwischenzeit ist in England und dem Commonwealth, in den Vereinigten Staaten von Nordamerika, Schweden, Deutschland und anderen Ländern über holzzerstörende Insekten und deren Bekämpfung viel gearbeitet worden. In Deutschland haben grundlegende biologische, ökologische, physiologische, toxikologische und technologische Untersuchungen der Institute und eine rege Entwicklungsarbeit der chemischen Industrie erfreuliche Fortschritte erbracht.

In der hier gegebenen kurzen Übersicht soll lediglich die Frage der Bekämpfung und Fernhaltung der Schädlinge unter Zugrundelegung der Verhältnisse in Deutschland verfolgt werden.

Zur *Abtötung der Schädlinge* im Holz wird in Deutschland gegenwärtig kaum noch Hitze oder Gas angewendet. Das erste Verfahren ist zu umständlich, kostspielig oder gefährlich, das zweite auf Dachböden selten durchführbar, und in beiden Fällen bedarf es zum vorbeugenden Schutze doch einer chemischen Nachbehandlung. Physikalische Verfahren wie Röntgenstrahlen, Hochfrequenz, Ultraschall oder Infrarot sind entweder zu teuer und mühsam oder (wie das letzte) unwirksam und konnten sich nicht durchsetzen. Aber nicht nur die Zahl, sondern auch die Wirksamkeit von Bekämpfungsflüssigkeiten wurde durch die chemische Industrie beachtlich erhöht.

Bei Kriegsende waren nur 2 ölige bzw. ölartige und 1 wasserlösliches Hausbockbekämpfungsmittel amtlich anerkannt. Nur so wenige Präparate bestanden die scharfe Prüfung, die neben der Wirksamkeit auf die verhältnismässig resistenten *Hylotrupes*-Larven in die Tiefe des befallenen Holzes hinein (untersucht nach DIN 52622) auch gewisse technologische Voraus-

setzungen fordert. Was diese anbetrifft, so soll besonders keine Erhöhung der Brennbarkeit des Holzes durch Öle und keine unzuträgliche Steigerung der Metallkorrosion durch wasserlösliche Mittel eintreten. Obwohl inzwischen durch Herabsetzung der Einwirkungszeit bei öligen und ölartigen Präparaten von 5 auf 3 Monate die Prüfbedingungen für sie noch etwas erschwert wurden, sind nunmehr 7- und wenn man die farblosen Varianten hinzurechnet, sogar 11-ölige und ölartige Hausbock- und Anobienbekämpfungsmittel der chemischen Industrie zugelassen, von denen keines mehr den früher benutzten völlig gleich ist. Die bereits erwähnten nicht färbenden Mittel sind für viele Anwendungszwecke sehr erwünscht oder allein anwendbar. Neuere Entwicklungen streben ferner bei organischen Präparaten eine Herabsetzung des oft störenden und ihre Anwendung häufig ausschliessenden Geruchs an.

Als Grundstoffe der *öligen und ölartigen Präparate* dienen auch weiterhin Steinkohlenteeröl-Destillate und chlorierte Kohlenwasserstoffe. Bei der chemischen Zusammensetzung der Mittel ist von vornherein unbedingt als eine der entscheidenden Voraussetzungen ihrer Eignung auf Erzielung eines guten Eindringvermögens in das Holz zu achten. Dabei sind zugleich die Netzfähigkeit und damit die Geschwindigkeit des Wegschlagens der Flüssigkeit an der Holzoberfläche, die vom Holz bei üblicher Behandlungsweise aufgenommene Schutzmittelmenge, die Eindringtiefe im Holz, das Vordringen des Präparates in den mit Frassmehl gefüllten Larvengängen sowie die Reichweite der Gaswirkung, also mehrere praktisch wichtige Faktoren, zu berücksichtigen. Zur Verbesserung der Wirksamkeit haben verschiedene Zusätze, besonders auch von neueren synthetischen Kontaktinsektiziden mit Gaswirkung, beigetragen. Die schnellere Wirkung der neuen Bekämpfungsmittel wie die stärkere Giftigkeit einzelner von ihnen im Vergleich zu anderen sind vor allem das Ergebnis solcher auch in Gasform wirkenden Kontaktgifte. Manche Präparate haben ausserdem Zusätze erhalten, die ihre Wirkungsdauer, die in allen Fällen gut sein muss, besonders verlängern soll.

Als Beispiele für die allgemeine Verbesserung der Mittel sollen einige Zahlen genannt werden. Die *Eindringtiefe in das Holz* wurde zwar grundsätzlich – abgesehen von wenigen Ausnahmen – im Vergleich zu den besten Präparaten bei Kriegsende nicht gesteigert. (Bekanntlich ist sie bei typischen Hausbock- und Anobienbekämpfungsmitteln von jeher besser als etwa bei dem für Kesseldrucktränkung so vielfältig bewährten Steinkohlenteeröl oder „Karbolineum"-Präparaten.) Aber das Vordringen der Flüssigkeiten in Bohrmehl steigerte sich, nach gewissen, hier nicht näher beschriebenen Verfahren bestimmt, durchschnittlich auf das 1,2 - bis 1,5 fache. – Die *Giftwirkung,* gemessen durch die Dosis letalis minima, d.h. Giftwertbestimmung bei langer Versuchszeit, wurde bei der Mehrzahl der jetzigen Präparate gegenüber den 1945 besten ungefähr verdoppelt. Beginnt man den Versuch nach 4 wöchiger Lagerung des getränkten Holzes bei 20° C, so genügen 1 bis 4 kg der Präparate, im Holz gleichmässig verteilt, um dieses gegen die Entwicklung von Hausbock-Eilarven zu schützen. Als bedeutend stärker vollends erweist sich die Verbesserung bei Berücksichtigung der Wirkungsgeschwin-

digkeit, die durch Giftwertbestimmung für kurze Versuchszeiten recht gut zu erfassen ist. Hier genügt grössenordnungsmässig der zehnte Teil wie früher, um unter den gleichen Bedingungen des vollgetränkten, wiederum 4 Wochen lang gelagerten Versuchsholzes denselben Abtötungserfolg zu erzielen.

Trotz der Verbesserung der Wirksamkeit, insbesondere der Wirkungsgeschwindigkeit, darf aber eine gewisse, verhaltnismässig hohe Mindestmenge an aufgebrachtem Bekämpfungsmittel nicht unterschritten werden. Das hängt mit dem Einfluss der Eindringtiefe der Flüssigkeiten in das Holz, die sich nicht wesentlich steigern liess, zusammen. Nur weiterreichende Gaswirkung verbessert den Erfolg gewisser Präparate. Bei den meisten sind etwa 500 g je m^2 Holzoberfläche zur Larvenbekämpfung durch Anstrich oder Ansprühen erforderlich. Nur ganz wenige erreichen dasselbe schon mit etwa 300 g.

Unter den *wasserlöslichen Stoffen* hat man sich von den als Bekämpfungsmitteln ungeeigneten Fluosilicaten abgewandt und als bisher einzig erfolgversprechenden Weg die Verwendung von Hydrogenfluoriden gefunden. Die letzteren besitzen im Vergleich zu den ersteren eine weit überlegene Eindringtiefe. Der Fluornachweis zeigt bei denselben aufgebrachten Mengen nach einiger Zeit einen 5- und mehrfachen Unterschied. Die Dosis letalis minima, die wiederum etwas über die untere Grenze der vorbeugenden Wirkung in vollgeschütztem Holz aussagt und daher interessiert, ist mit 0,2 bis 0,4 kg je m^3 Holz bei beiden Verbindungsgruppen zwar annähernd gleich; die für eine Bekämpfung der Schädlinge entscheidende Wirkungsgeschwindigkeit ist aber ausserordentlich verschieden. Diese wie das gute Eindringvermögen sind bei den Hydrogenfluoriden durch ihre Fluorwasserstoffabgabe in Gasform bedingt.

Obwohl diese Fluorwasserstoff-Gasabgabe eine Zunahme der Fluor-Eindringtiefe auch bei niedrigerer Luftfeuchtigkeit, bei der jede Wanderung anderer Salze im Holz aufhört, bewirkt, hat es sich doch als zweckmässig erwiesen, zur Bekämpfung eine hohe Holzfeuchtigkeit zu schaffen und für einige Zeit nach der Behandlung zu erhalten. Dadurch kann ein tiefreichender Behandlungserfolg in verhältnismässig kurzer Zeit erreicht werden.

Der *vorbeugende Schutz* des Holzes hat im Rahmen des erforderlichen Wiederaufbaues der zerstörten Städte in Europa eine grössere Bedeutung. Zum lediglich vorbeugenden Schutz, den natürlich auch die Bekämpfungsmittel hinreichend lange gewährleisten müssen, kommen wesentlich mehr Verbindungen und Mischpräparate, besonders auch aus dem anorganischen Bereich, in Betracht, und eine verhaltnismässig grosse Zahl ist amtlich anerkannt, nämlich etwa 40 wasserlösliche und etwa 10 ölige und ölartige ausser den auch für Bekämpfung zugelassenen. Für den Holzschutzmittelverbraucher ist diese Präparat- und Namenfülle schwierig und oft verwirrend. Eine Zusammenfassung von Mitteln mit ähnlicher chemischer Zusammensetzung, Anwendungs- und Wirkungsweise durch den Prüfausschuss für Holzschutzmittel hat vor kurzem endlich eine Erleichterung gebracht. Gegenüber der Zeit bis Kriegsende verwendet man in zunehmendem Masse statt Zinkfluosilicat die wirksamere Magnesium-Verbindung. Ein Verschnitt des letzteren mit der bil-

ligeren Zinkverbindung geht nur in begrenztem Masse, wie neuere Untersuchungen gezeigt haben. Neben der Anwendung verschiedener anderer anorganischer Salze und Salzmischungen, auf die hier nicht im einzelnen eingegangen werden kann und soll, finden Kontaktinsektizide und Pentachlorphenol steigende Beachtung. Die Empfindlichkeit gegen die bekannten Kontaktinsektizide ist bei den holzfressenden Larven in grossen Zügen ähnlich wie bei anderen Insekten abgestuft.

Bei den *Prüfungen* auf vorbeugende Wirkung werden Eilarven des Hausbockkäfers, des wichtigsten holzzerstörenden Insekts in den meisten Teilen Europas, verwendet. Das die Lebensbedingungen berücksichtigende und die praktischen Verhältnisse bestens, wenn auch in verschärfter Form wiedergebende Prüfverfahren DIN 52621 hat sich durchaus bewährt. Es zeigt sich, dass es chemisch gar nicht sehr leicht ist, mit Hilfe von einfachen Einbringverfahren des Streichens, Spritzens oder Kurztauchens (dipping) die ja nur einen Randschutz ergeben, das Einbohren der *Hylotrupes* - Eilarven durch die getränkte Schicht in das unvergiftete und weiterhin zerstörbare Holzinnere hinein zu verbinden. Neuerdings ergab sich beispielsweise, dass das für sich allein auch gegen Hausbocklarven so wirksame Pentachlorphenol, in gewissen Trägerstoffen gelöst und auf das Holz nur aufgebracht, zwar in dieser Form gegen das Eindringen verschiedener anderer holzzerstörender Insekten durch die behandelte Holzschicht schützt, gegen Hausbock-Eilarven aber versagt. Erfahrungen mit den viel kleineren Anobien- und *Lyctus*-Eilarven kann man nicht auf den Hausbock übertragen.

Giftwertbestimmungen nach DIN 52623 sind auch bei der Prüfung der vorbeugenden Wirkung zweckmässig, um die Sicherheit des Schutzes beurteilen zu können. Das gilt natürlich in erster Linie für vollgeschütztes Holz, hat aber ebenso für Randschutzmassnahmen Bedeutung, wenn auch hier die spezifische Art der Wirksamkeit als Atmungs-, Ätz-, Kontakt- oder Frassgift sehr wichtig ist. Die viel benutzten halberwachsenen Anobienlarven waren und sind infolge ihrer Resistenz gegen Frassgifte zur Auffindung rasch wirksamer Atmungs-, Ätz- oder Kontaktgifte von Nutzen.

Bei den für den Export bestimmten Präparaten werden als Holzschädlinge bei den Prüfungen auch *Termiten* berücksichtigt. Geeignete Laboratoriumsversuche, bei denen Auswasch- und Verdunstungsbeanspruchung der Mittel durch tropische Bedingungen berücksichtigt werden müssen, können Aufwand, Geld und Zeit für die entscheidenden Freilanderfahrungen in den Tropen ersparen helfen. Methodik und Ergebnisse sollen hier nicht erörtert werden.

Ziel vieler Industrie-Entwicklungen ist *Vereinigung von Schutz gegen Insekten, holzzerstörende Pilze und Feuer.* Von den bisherigen gegen Insekten brauchbaren Holzschutzmitteln sind alle zugleich auch gegen Pilze hinreichend wirksam; das Umgekehrte gilt aber keineswegs. Die Brennbarkeit des behandelten Holzes darf weder bei Bekämpfungs- noch bei vorbeugenden Mitteln erhöht werden. Es gibt Holzschutzpräparate gegen Insekten, die eine gewisse Herabsetzung der Brennbarkeit des behandelten Holzes bewirken, ohne damit als „Feuerschutzmittel" im eigentlichen Sinne gelten zu kön-

nen. Einige amtlich anerkannte Feuerschutzmittel schützen zugleich vorbeugend gegen die Holzschädlinge. Insektenbekämpfung und starke brandhemmende Wirkung liessen sich aber bisher nicht vereinigen.

In der *Anwendungstechnik* wird angestrebt, einen Tiefschutz des Holzes zu erreichen. Denn immer wieder muss betont werden, wie wichtig dies auch beim vorbeugenden Schutz ist. Neue Trockenrisse, die tiefer reichen als die durchtränkte Holzschicht, können das giftigste und beste Schutzmittel wirkungslos machen, weil durch sie den Larven der Weg ins ungeschützte Holzinnere geöffnet wird. Die Auswirkung der allmählichen Diffusion von Salzen ist zu beachten und noch genauer, als es bereits geschehen ist, zu untersuchen. Für das im Freiland verwendete Holz ist hinreichende Auswaschbeständigkeit der Schutzsalze eine Voraussetzung. Am Anfang der experimentellen Verfolgung schliesslich steht die wichtige Frage der Dauer des Schutzes bei allmählich verdunstenden Präparaten; doch weiss man, dass die amtlich anerkannten alle fur eine lange Zeit schützen.

Nach einer hinter uns liegenden Periode biologischer und ökologisch-physiologischer Arbeit und der Entwicklung und gründlichen Erforschung geeigneter Holzschutzmittel gegen Insekten ist es nunmehr wichtig, immer weitere Kreise an deren Holz – diesen knappen Rohstoff in Europa – Arbeitsleistung und Geld ersparende Benutzung zu gewöhnen und mit den bestmöglichen Anwendungsformen vertraut zu machen.

DISCUSSION

Mr. **Bletchly**: Haben Sie Ergebnisse über die Abhängigkeit der Eiablage von der Holzfeuchtigkeit (Platzwahl und Eizahl)?

Mr. **Becker**: No experiments have so far been carried out on the possibility of females selecting wood of any particular moisture content for egg laying nor on the total number of eggs which are laid at different humidities. As pointed out in my paper there are practical difficulties in obtaining accurate total egg counts.

A SUMMARY OF SOME RECENT WORK ON THE FACTORS AFFECTING EGG-LAYING AND HATCHING IN ANOBIUM PUNCTATUM DE G. (Coleoptera-Anobiidae)

by

J.D.BLETCHLY

Princes Risborough, Bucks, England

Introduction

Within the last fifteen years considerable attention has been given to a study of the biology of *Anobium punctatum* De G., in Germany (BECKER, 1940, 1942) and more recently in New Zealand (KELSEY, 1947; SPILLER, 1948) and important advances in the knowledge of its habits in these countries and of special laboratory techniques have resulted. There are, however, serious gaps in this knowledge, particularly with regard to the conditions in wood rendering it suitable for infestation: for example, this species does not appear to attack wood when newly seasoned but prefers it after it has been in use for a number of years; the explanation of this is not known. In view of this, and in order to obtain information on its habits in the British Isles for comparison with the results obtained elsewhere, investigations on this beetle, popularly known as the common furniture beetle, are now in progress at the Forest Products Research Laboratory. A study of the biology of this insect was started in 1939 but, interrupted by the war, was not re-commenced until 1948. Unpublished results of some of these early investigations by FISHER and HARRIS at this Laboratory are included in the data now presented, but, in their experiments, decayed wood was employed without the addition of the artificial muslin surface for egg-laying as used in the later work described below.

Owing to lack of knowledge of the factors most favourable for attack, it has proved difficult to breed this species in the laboratory and, so far, no method of reducing the length of the life cycle has been found.

Oviposition

Technique employed. Under normal conditions the eggs, which are comparatively few, are laid on rough surfaces, in particular on the end grain and in old flight holes. New Zealand workers (KELSEY, 1947) have taken advantage of this habit to improvise an artificial surface by fixing muslin to experimental wood blocks with an adhesive, in order to provide a suitable surface which, at the same time, facilitates egg counts. This method, however, proved not to be entirely appropriate to the present investigations at this Laboratory owing to the introduction of an extraneous nutritional substance in the form of the starch paste adhesive, and to a tendency of the larvae to feed in this layer without entering the blocks normally. Modifications were accordingly tried such as the use of a non-nutritional adhesive

(heated perforated mica paper) but few eggs were laid and hardly any larvae entered the blocks. Similarly, artificial roughening of the wood surfaces also proved unsatisfactory. A muslin technique which eliminates an adhesive has proved suitable and has been adopted (Fig. 1). The method consists of winding a number of strands of No. 40 cotton round the wood block (cut radially or tangentially in the direction of the grain), placing a small strip of butter muslin over the two end grain (transverse) faces and binding these two strips firmly to the block with further strands of the cotton, in order to ensure that all the eggs are laid on the muslin placed across the end grain and none between the threads and muslin on the other two surfaces, the latter are protected with an adhesive tape. In this way the beetles are forced to lay their eggs on the end grain faces only (Fig. 2).

Choice of site. There are indications that the females have powers of discrimination with regard to surfaces suitable for egg-laying. For instance, experiments carried out with plywood made up with three different glues (blood, hide and urea formaldehyde) have shown that more eggs were laid on the blocks with blood and animal glue than on those with synthetic glue (Table 1). This is of interest in connection with the severe attack often found in the cheaper grades of plywood made up with blood and animal glues (FISHER, 1949).

In the following table the data given represent the analysis of the results of a series of experiments conducted in several containers in an incubator. Three groups of equal numbers of blocks, each group made up with one of the glues previously mentioned, were arranged at random in the containers. In some containers all the blocks were of beech, in others of Scots pine, and in others equal numbers of blocks made from these two species of wood were mixed. In all 148 females were used. The results obtained from the individual containers did not differ appreciably on the average.

Table 1. Egg-laying in relation to types of adhesive in plywood

Species of wood	Total eggs laid	Percentage of eggs laid on approximately equal surface areas according to adhesive used		
		Blood	Hide	Urea formaldehyde
Scots pine (*Pinus silvestris*)	485	41.9%	36.9%	21.2%
Beech (*Fagus sylvatica*)	791	42.5%	37.4%	20.1%

At 22° C. and 76% R.H.

Number of eggs laid per female. An average value is difficult to obtain; for example, more eggs have been laid by females collected early

Fig. 1. MUSLIN TECHNIQUE FOR OVIPOSITION (Forest Products Research Laboratory, D.S.I.R., Crown Copyright Reserved).

Fig. 2. EGGS LAID IN MESH OF MUSLIN ON END GRAIN FACE (Forest Products Research Laboratory, D.S.I.R., Crown Copyright Reserved).

in the emergence period than by those which have been collected later. The females not only spend much time in exit holes and frequently mate there but also re-enter exit holes, and it has been observed that some eggs are laid there. It is, therefore, probable that some egg-laying has already taken place in many instances prior to collection, at any rate in the case of females obtained later in the season. In spite of the fact that dissection has revealed that the females are capable of laying upwards of 60 eggs, it is unusual to obtain an average of more than 28 even from individuals taken after emergence early in the season, and generally the number is considerably less.

The viability and incubation period of the egg

Under controlled conditions of temperature and humidity. The data summarised in Table 2 concerning the effect of varying conditions of temperature and humidity upon the viability and incubation period of the eggs of ***Anobium punctatum*** during the emergence period, are based on experiments conducted over several years in incubators and a humidity room: the containers used were mostly desiccators but a few of other types were also employed. Humidity was controlled by aqueous dilutions of sulphuric acid or solutions of potassium hydroxide calculated from the information given by BUXTON (1931). The actual humidities obtained were measured by special check wood samples which were included in the desiccators.

The data for viability include both fertile and infertile eggs, but eggs damaged during examination are not included. In this and the following tables, the figures in parentheses represent the number of eggs on which observations were made.

Table 2. Incubation period and viability of eggs in relation to humidity at 20° C.

Relative Humidity	Viability %	Average Incubation Period in Days
28	0 (149)	No hatching (149)
33	31 (177)	19.2 (50)
43	66 (275)	23.3 (140)
56	71 (252)	18.3 (121)
66	90 (168)	18.6 (134)
76	74 (90) (A)	16.7 (47)
76	-	17.1 (115) at 22°C.
76	-	16.4 (23) at 25°C.
85	-	17.6 (10) at 22°C.
87	91 (184)	15.5 (96)
90	76 (124) (B)	Not obtained

(A) This figure includes an abnormally high proportion of infertile eggs.
(B) No figures available for the number of infertile eggs.

Out-of-doors. Data collected in the years, 1939, 1940, 1941, 1948, 1949 and 1951 are summarised in Table 3.

Since no accurate figures are available for average relative humidity out-of-doors at this Laboratory, data have been used from the published "Monthly Weather Reports" of the Meteorological Office. From these records for the Midland area (in which this Laboratory lies), it is found that the relative humidity never fell below 64% in 1939 and 1948, but in 1949 a minimum of 50% was recorded in July. On the assumption that the relative humidity at 09.00 hours (British Summer Time) is approximately the average for the day, the mean figures for the Midlands during the relevant incubation periods are given in the following table for the three years for which records are available. The temperatures were recorded from a thermograph at this Laboratory and average values calculated from the readings at four-hourly intervals: in 1951, however, the only readings available were taken from a dry bulb thermometer at 10.00 hours (B.S.T.) daily.

Table 3. Incubation period of eggs in relation to temperature and humidity out-of-doors

Average Incubation Period (Days)	Average Temperature During Period (°C)	Mean Relative Humidity During Period (%)	Year
30 (38)	18.0	-	1941
30 (37)	17.1	72	1949
34 (6)	15.7	-	1940
34 (42)	16.1	77	1939
35 (29)	16.1	-	1951
39 (17)	14.5	80	1948

Under laboratory conditions. Records have been obtained only for the years 1940 and 1951. Temperature and relative humidity readings are not available.

Table 4. Incubation period of eggs under laboratory conditions

Average Incubation Period in Days	Year
23 (49)	1940
31 (15)	1951

Discussion. It appears from Table 2 that at 20° C., relative humidities of the order of 56% are somewhat critical. Above that figure conditions are suitable for the hatching of the eggs and higher humidities have little effect in shortening the incubation period. Below 56% relative humidity, the incubation period becomes somewhat longer and viability decreases. Whilst

no detailed figures are available, it appears that, during the period June to August, the relative humidity under normal circumstances in a dwelling house exceeds 56% but will vary according to the type and situation of the building and in individual rooms, quite apart from the effect of variations in relative humidity out-of-doors.

These experiments and observations upon the effect of relative humidity on the incubation period and viability of the eggs in general confirm the conclusions reached by BECKER (1940) and SPILLER (1948). BECKER, using temperatures of 20° C. and 28° C., found that higher humidities affected the egg period to only a slight extent, but that the mortality increased at lower humidities. SPILLER, working at 22.5° C., stated that hatching is independent of humidity above 65%, is impaired between 50% and 60%, and that hatching does not take place at humidities of 45% and below.

It would appear from Table 3 that the effect of temperature on the length of the incubation period is greater than that of humidity, higher average temperatures shortening the incubation period. The data in Table 2 appear to give somewhat conflicting results with regard to the influence of temperature, but the probable explanation for this is the absence of cooling facilities to prevent the temperature from rising above 20° C. on warm days.

Under laboratory conditions in the United Kingdom, the incubation period lies, as might be expected, between those obtained in an incubator at 20° C. and out-of-doors (Table 4).

In general, it may be concluded that under all three conditions (incubator, laboratory and out-of-doors) the limits of variation in the time the eggs take to hatch are considerable. For instance, in the incubator at 22° C. and 76% relative humidity, some eggs took only 12 days and others 20 or more days to hatch. The wide differences in the figures for the incubation period under laboratory conditions for 1940 and 1951 may also be due to this variation but further work is needed.

Establishment of first-stage larvae

Experiments designed to investigate the effect of decay in wood on the length of the life cycle have yielded some interesting results on the establishment of the first-stage larvae. For instance, at 22° C. and 76% relative humidity, only about half of the larvae which hatched succeeded in establishing themselves in sound wood, but, where some decay was present, a higher proportion was successful: of the three species of wood used in the experiment, this was most apparent in beech (*Fagus sylvatica*). (Table 5)

The presence of only slight fungal decay appears to be sufficient to facilitate the entry and successful establishment of the first-stage larva, but the data obtained in the case of beech suggests that more extensive decay may have no further effect in this connection. It is probable that decay renders the surface easier to penetrate, but experimental work has also shown that decayed wood is suitable for larvae in other respects in so far as they develop more rapidly in it than in sound wood. Work on the relation-

Species	In wood decayed by *Polystictus versicolor* Extent of decay expressed as percentage loss in weight						In so Woo
	6-10 %	11-20 %	31-40 %	41-50 %	51-60 %	61-70 %	
Beech (*Fagus sylvatica*)	86 (174) *	88 (196)	80 (50)	65 (194)	86 (64)	73 (182)	42 (3
Turkey oak sapwood (*Quercus cerris*)	70 (61)	73 (51)	100 (5)	-	96 (48)	72 (43)	65 (1
Scots pine sapwood (*Pinus sylvestris*)	81 (353)	76 (17)	-	-	-	-	60 (3

Table 5. Effect of fungal decay on establishment of first-stage larvae at 22° C. and 76% relative humidity. – Percentage successful larval entry

ship between extent of decay in wood and other factors affecting its suitability for infestation by this insect is continuing at the Forest Products Research Laboratory, Princes Risborough.

Acknowledgments

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*) Figures in brackets give numbers of eggs hatched

UBER LARVENENTWICKLUNG UND GENERATIONSVERHALTNISSE BEI HYLECOETUS DERMESTOIDES L. (COLEOPTERA, LYMEXYLIDAE)

von
H.FRANCKE-GROSMANN
Reinbek-Hamburg, Deutschland

Hylecoetus dermestoides brütet im Sachsenwald bei Hamburg häufig an Stubben von Laub- und Nadelholz. Unter den Laubhölzern bevorzügt er Buche und Eiche, selten kommt er auch in Birke vor, unter den Nadelhölzern Fichte, Douglasie, Lärche. Sehr selten befällt er Kiefernstubben.

In der Nachkriegszeit hatte in verschiedenen Revierteilen eine Übervermehrung des Käfers an Eichenstämmen stattgefunden, die aus wirtschaftlichen Gründen ein, zwei und auch drei Jahre lang im Walde verblieben waren. Von hunderten von Starkholz-Eichenstämmen waren etwa 50% von *Hylecoetus* befallen. Ein erheblicher Teil davon war weitgehend entwertet oder unbrauchbar geworden. Das gab den Anlass zu Untersuchungen über die Lebensweise des Käfers, über dessen Generationsverhältnisse in Norddeutschland noch keine Klarheit herrschte und über dessen Larvenentwicklung noch sehr wenig bekannt war.

Die alte Lehrmeinung nimmt eine einjährige Larvenentwicklung an. RICHTER (1933) war der erste, der diese umstürzte. Er konnte für Mitteldeutschland eine ein-, zwei-, gelegentlich auch dreijährige Entwicklung für *Hylecoetus dermestoides* feststellen. THOMSEN (1949) fand neuderdings eine zwei- oder dreijährige Entwicklungszeit in Dänemark.

Die Generationsverhältnisse sind bei diesem Käfer aus verschiedenen Gründen unübersichtlich. Der gleiche Stamm oder Stubben kann insbesondere bei Laubholz, seltener bei Nadelholz unter Umständen an zwei aufeinanderfolgenden Jahren von den Käfern belegt werden. Das Alter der Larven ist schwer zu schätzen, da gleichalte Larven selbst im gleichen Holzabschnitt sehr verschieden gross sein können. Die Länge der Weibchen schwankt zwischen 0.65 und 2.2 mm, die der Männchen zwischen 0.5 und 1.2 cm (Abb. 1). Auch die relative Länge des für die *Hylecoetus*-Larven charakteristischen Schwanzfortsatzes gibt, da sie sehr variabel ist, keine Anhaltspunkte für die Altersbestimmung. Eine 22 cm lange weibliche Larve kann einen Schwanzfortsatz von 0.7 mm oder einen solchen von 3.9 mm besitzen; das bedeutet, dass das Verhältnis von Gesamtkörperlänge zur Schwanzfortsatzlänge zwischen 5.5 und 30 schwankt.

Um über den prozentualen Anteil der einzelnen Entwicklungsstadien der Population während der Flugzeit der Käfer einen Überblick zu gewinnen, wurde die Ausbeute einer Reihe von Fangtagen im Frühjahr 1950 nach Entwicklungsstadien getrennt registriert und aufgezeichnet (Abb. 2). Es zeigte sich dabei, dass die Flugzeit der Käfer scharf umrissen war und vom 2.V. bis 3.VI.

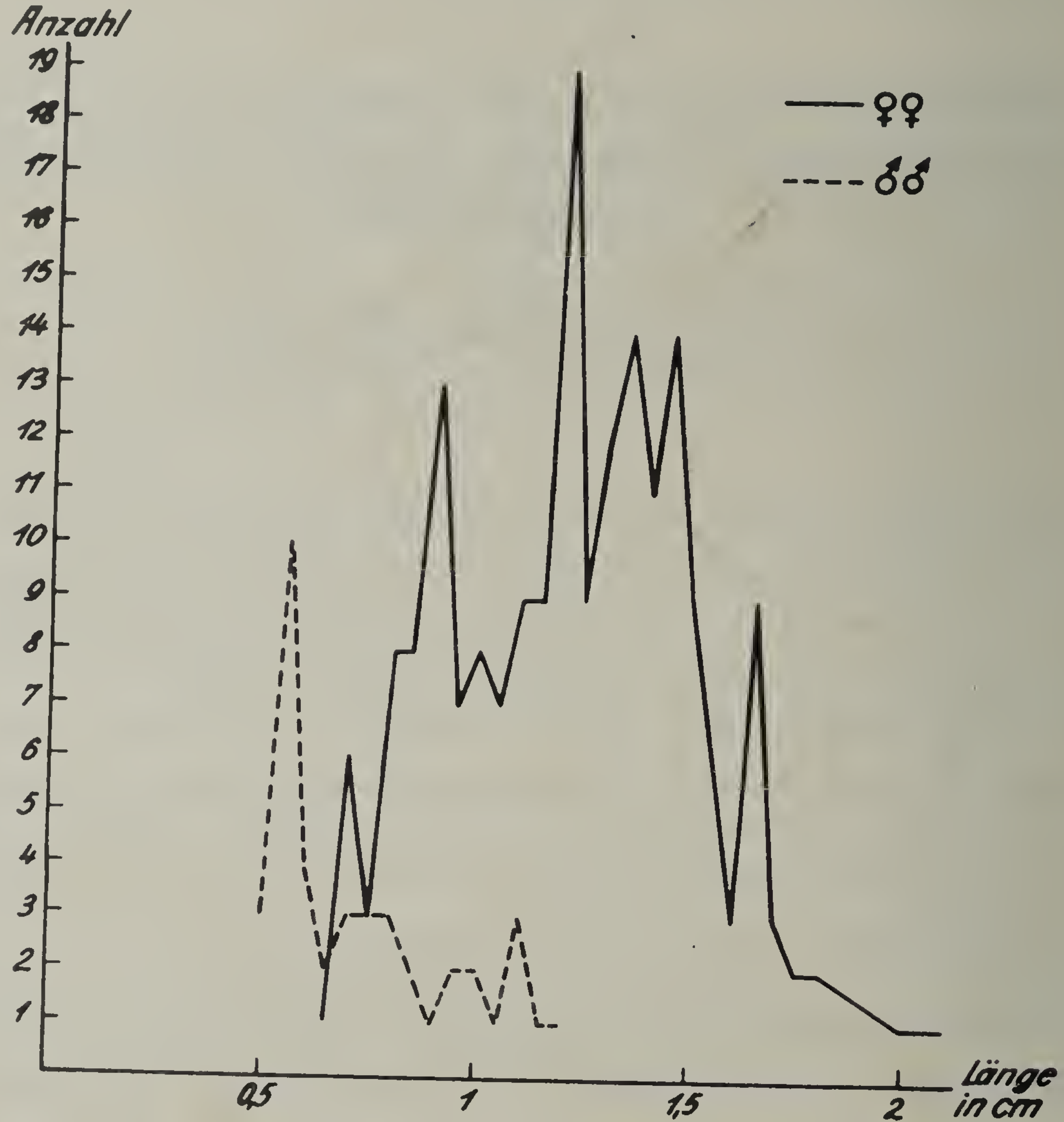

Abb. 1 — Körperlängen einer Serie von *Hylecoetus*-Männchen und Weibchen aus Buche.

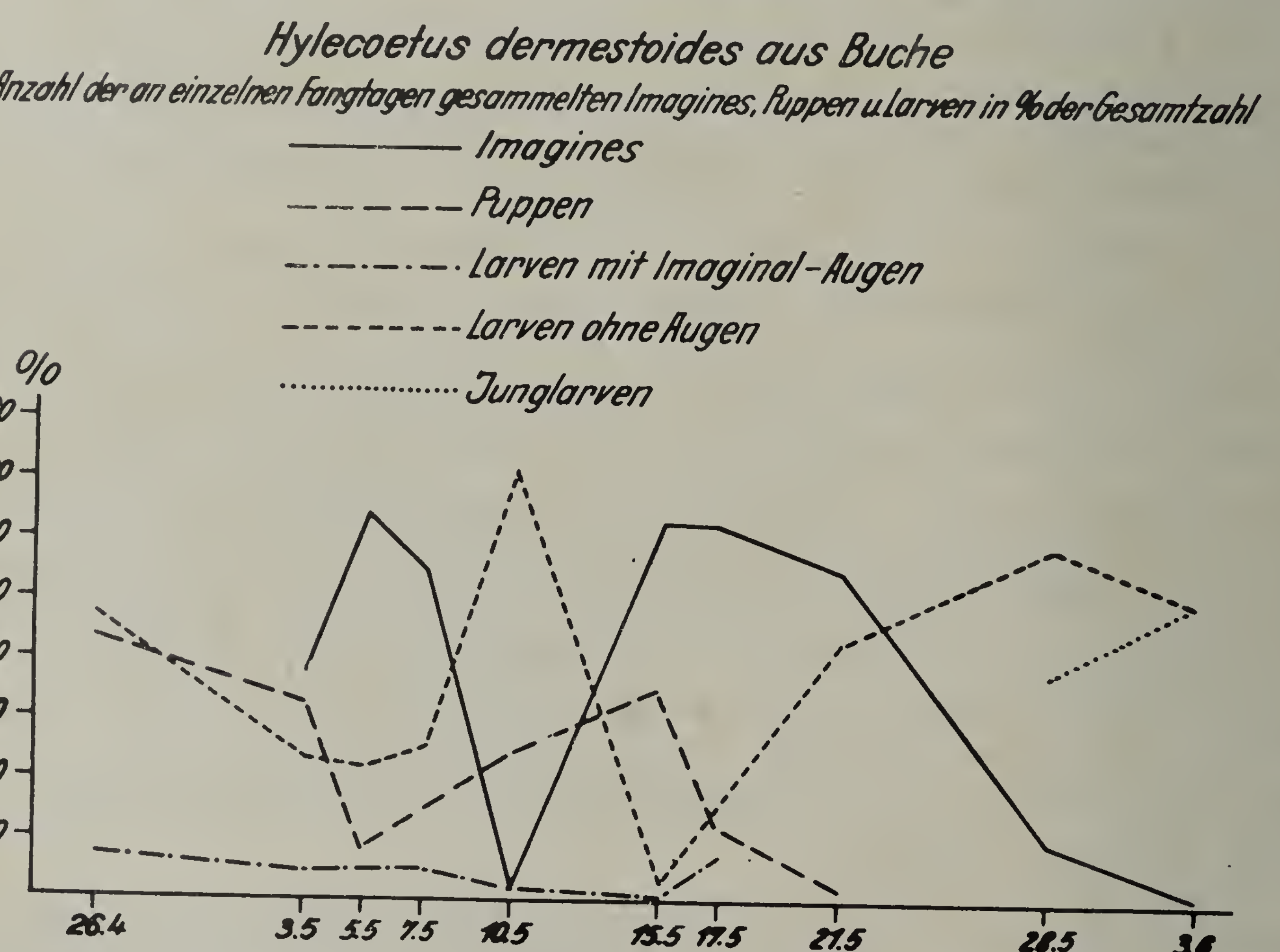

Abb. 2 — Verhältnis der einzelnen Entwicklungsstadien verschiedener Fangausbeuten im Frühjahr 1950.

dauert, nach welchem Zeitpunkt bis zum Herbst weder Käfer noch erwachsene Larven mit Imaginalaugenanlagen oder Puppen gefunden werden konnten. Am Schluss der Flugzeit waren in etwa gleichem Verhältnis Junglarven im ersten, zweiten oder dritten Entwicklungsstadium neben gut entwickelten alten Larven aus dem vorigen Jahr zu finden. Schon äusserlich war der frische Befall an feinerem und spärlicherem Bohrmehl von dem vorjährigen Befall, mit seinen Bohrmehlansammlungen zwischen den Wurzelanläufen und den gröberen, reichlicheren Bohrspänen zu erkennen. Da am Schluss der Flugzeit vorjährige und junge Larven nebeneinander vorhanden sind, ist erwiesen, dass die Entwicklung der *Hylecoetus*-Larven unter den gegebenen klimatischen Verhältnissen länger als ein Jahr dauern kann.

Die Kenntnis der Junglarvenstadien kann unter Umständen von Nutzen sein um das Alter eines Befalls zu schätzen. Ausser dem Eilarvenstadium und einer von BOAS abgebildeten älteren Junglarve unbestimmten Alters war bisher noch nichts über die Larvenentwicklung des *Hylecoetus* bekannt. Die Junglarven wurden daher einem eingehenden Studium unterzogen. Die Häute, welche von den Larven jeweils in Abständen von 6 oder 7 Tagen aus der erweiterten Auswurföffnung herausbefördert werden, zeigten, dass das beste Kennzeichen der einzelnen Stadien der Schwanzfortsatz ist, der sich nur ausserordentlich langsam zu seiner endgültigen Gestalt entwickelt. Das hat seinen Grund zweifellos darin, dass der Schwanzfortsatz ein ziemlich stark chitinisiertes, starres Gebilde ist, das zunächst als Abdruck des alten an der neuen Haut entsteht und während des zwischen den Häutungen stattfindenden Längenwachstums der Larve sich nur wenig strecken kann.

Die anfangs fast kreisrunde Scheibe am Hinterende der freilebenden, walzenförmigen mit Punktaugen versehenen Eilarve, die durch lange geknöpfte Tasthaare ausgezeichnet ist, verändert ihre Gestalt nach der ersten Häutung wenig. Die weiteren Larvenstadien sind durch eine Streckung des Schwanzfortsatzes gekennzeichnet, verbunden mit einer stärkeren Ausbildung der Chitinhaken am Hinterende (Abb. 3). Das fünfte Stadium entspricht der bei BOAS abgebildeten Junglarve. Bis zum 6. Stadium verläuft die Entwicklung ziemlich einheitlich, später machen sich die individuellen Unterschiede stark bemerkbar, sodass nun, da die Häutungen aus technischen Gründen nicht alle an ein und demselben Individuum beobachtet werden könnten, gewisse Unsicherheiten auftreten. Die Streckung des Schwanzfortsatzes geht jetzt schneller vor sich (Abb. 4) und betrifft besonders die proximalen Teile, sodass die seitliche Bezahnung immer mehr auf das Hinterende des Fortsatzes rückt. Nach der 10. Häutung sind keine Merkmale für das Alter der Larve mehr zu erkennen. Der Pigmentfleck, der an der Stelle der Eilarven-Augen bei den jungeren Stadien noch deutlich sichtbar ist, ist nun schon stark reduziert aber immer noch nachweisbar. Die weitere Entwicklung entzog sich der Beobachtung, es ist jedoch sicher, dass noch mehrere Häutungen bis zum Erscheinen der Imaginalaugen an der verpuppungsreifen Larve stattfinden. Wieviele dieses sind, und ob ihre Zahl bei allen Larven konstant ist, bleibt noch ungeklärt. Im Laubholz lassen sich die jungendlichen Larven neben den vor-

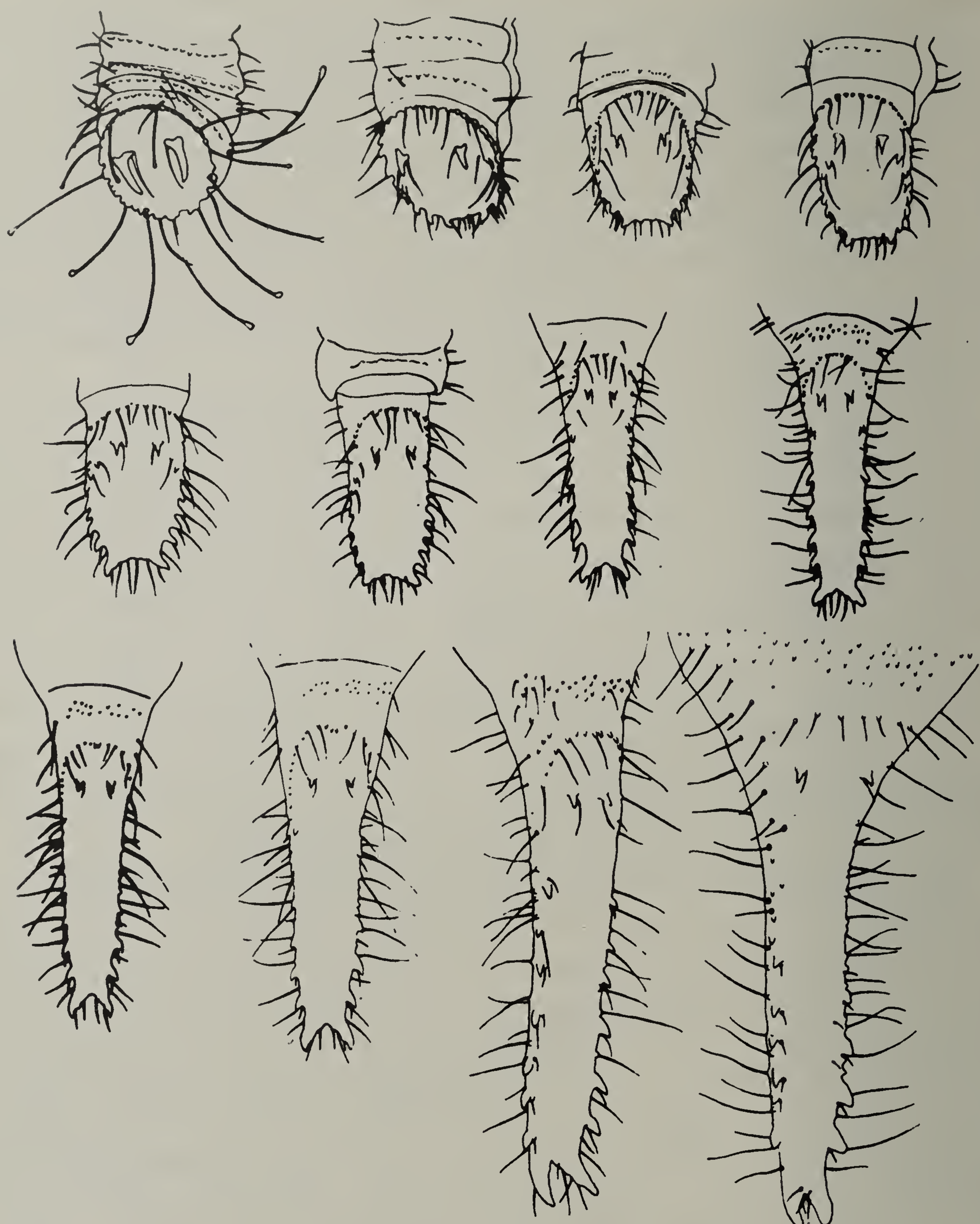

Abb. 3 — Hinterenden von elf Junglarven und einer verpuppungsreifen Larve mit kurzem Schwanzfortsatz.

jährigen im allgemeinen bis etwa Mitte August sicher unterscheiden, bei Befall von Nadelholz verwischen sich die Unterschiede schon früher.

Die Frage, ob neben der mehrjährigen auch eine einjährige Entwicklung bei *Hylecoetus* vorkommen kann, liess sich an Hand der Buchführung in den Forstämtern des Sachsenwaldes leicht beantworten.

Ein Windwurf vom Oktober 1949 in einem Douglasienbestand, dem etwa 20 Stämme zum Opfer gefallen waren, war im November 1949 aufgearbeitet

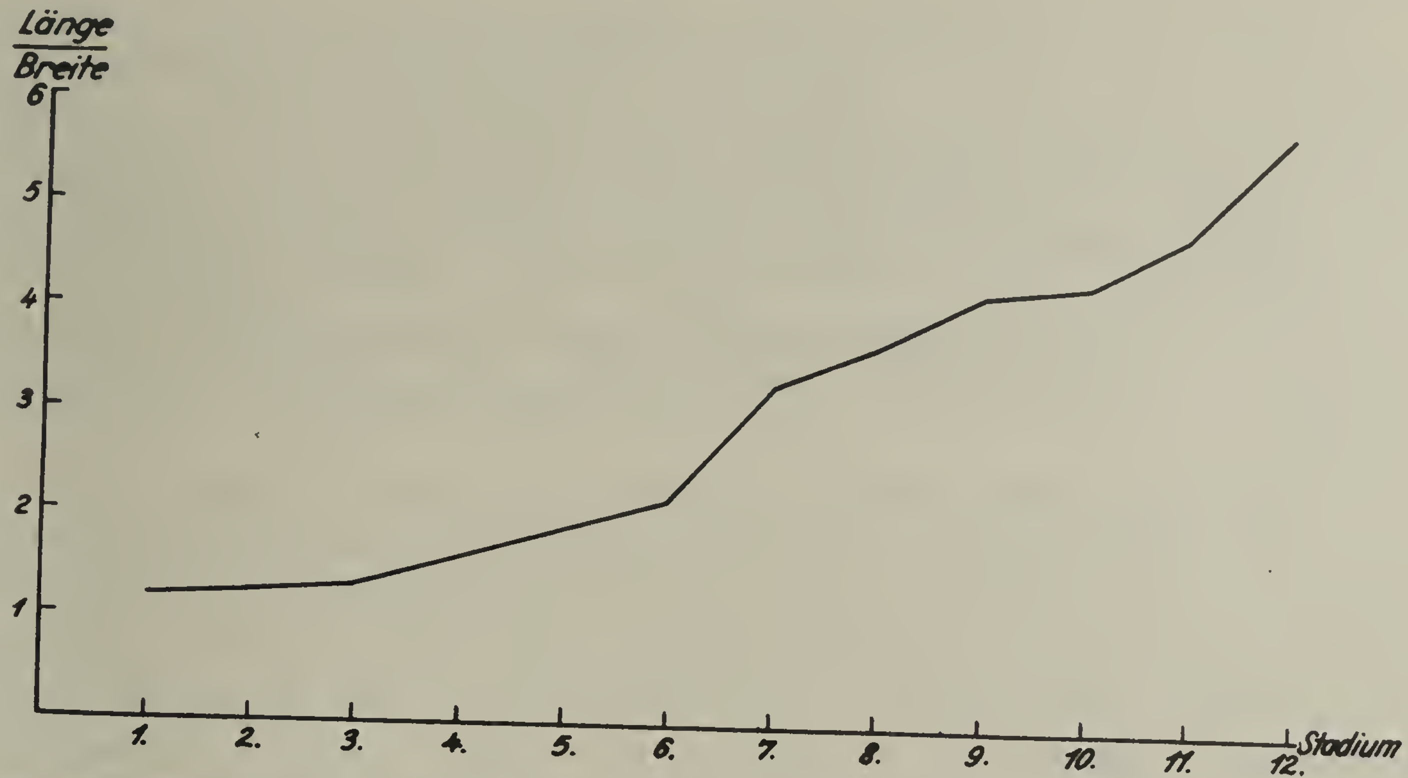

Abb. 4 – Verhältnis von Länge zur Breite des Schwanzfortsatzes der verschiedenen Larvenstadien.

worden. Die Stubben waren im Frühjahr 1950 sämtlich von *Hylecoetus* belegt worden. Eine Kontrolle nach Beendigung der Flugzeit am 6. Juni 1951 ergab, dass etwa 25% der vorjährigen Larven noch vorhanden waren, 75% hatten sich, wie an den Ausfluglöchern ersichtlich, zu Käfern entwickelt. Der grösste Teil der Larven hatte demnach eine einjährige Entwicklungsdauer gehabt. Ähnliche Beobachtungen konnten in einem Fichtenbestand gemacht werden, wo der Prozentsatz der nach einem Jahr ausgeflogenen Käfer noch höher war.

Die Entwicklung im Laubholz scheint dagegen viel häufiger verzögert, wie zahlreiche Beobachtungen an Buchenstubben und an Eichenstämmen, deren Fällzeit bekannt war, zeigten. Es sei nur ein Beispiel herausgegriffen:

Ein Eichenstamm, der laut Auszeichnungsnummer im November 1948 gefällt worden war, war im Frühling 1949 von *Hylecoetus* stark beflogen worden. Ende April 1950 wurde ein kleiner Teil der Stammrinde entfernt. Es konnte festgestellt werden, dass etwas die Hälfte der zahlreichen Larvengänge ganz normal radial ins Holz hinein verliefen, die übrigen peripher wie die von RUMMUKAINEN in Birke beobachteten. In den radialen Gängen fanden sich zum Teil schon fertige Puppen und schlüpfbereite Käfer vor; die Larven in den peripheren waren alle noch auffallend unentwickelt, einige befanden sich erst im 8. oder 9. Stadium. Eine Kontrolle nach Abschluss der Flugzeit des Käfers ergab, dass sich etwa 50% der Larven aus den radialen Gängen zu Imagines entwickelt hatten, während die Larven in den peripheren Gängen samtlich noch vorhanden waren. Es hatten sich also in diesem Fallen 25% der Larven in nur einem Jahr zu Käfern entwickelt, der Rest, etwa 75%, benötigte zum Mindesten noch ein weiteres Jahr. Da zahlreiche Beobachtungen zeigten, dass aus Eichenstämmen, die den dritten Sommer im Walde lagerten, meist alle Käfer ausgeflogen waren, ist anzunehmen, dass eine dreijährige Entwicklung, wenn überhaupt, nur selten vorkommt.

Bei dem eben geschilderten Fall war auffallend, dass der symbiontische Ambrosiapilz des Käfers in den radialen Gängen normal, d.h. mässig, in den peripheren dagegen ausserordentlich üppig entwickelt war. An abgelösten Rindenstücken wucherte er in der feuchten Kammer an den Larvengangwänden, und zwar ausschliesslich an diesen, in dichten, weissen Polstern. Ein Querschnitt liess den typischen Ambrosiarasen erkennen, daneben als begleitende Pilze einige *Ophiostoma*-Arten und ein *Leptographium*. Diese Begleitpilze wechseln mit der Holzart, während der Ambrosiapilz immer der gleiche ist.

In den Puppenwiegen fanden sich die schon vor 25 Jahren von PAUL BUCHNER beschriebenen und auf Grund morphologischer Befunde als Fruchtformen des Ambrosiapilzes erkannten einzeln oder büschelweise wachsenden Schläuche vor, deren Zugehörigkeit zu dem Ambrosiapilz nun auch experimentell bestätigt werden konnte. Aus Stecklingen des Ambrosiarasens, aus den Sporen der Schläuche, aus den Sporen in den von BUCHNER beschriebenen Übertragungstaschen am Legeapparat der weiblichen Kafer, von den unter sterilen Bedingungen abgelegten Eiern und aus der Kriechspur der Eilarven liess sich das gleiche weisse, raschwüchsige, anfangs nach Rosen, später nach reifen Äpflen duftende Mycel züchten, das auf Malzagar allerdings keine Schläuche und nur spärliche Ansätze zu „Ambrosia"-Bildung hervorbrachte. Die nackten Schläuche mit den sehr zahlreichen kleinen Sporen lassen den Ambrosiapilz des *Hylecoetus dermestoides* als zu den primitiven Ascomyceten gehörig erkennen.

Vielleicht wegen dieser Pilzzucht sind die Ansprüche, die der Käfer an das von ihm befallene Holz stellt, sehr ausgeprägt. Er benötigt einen bestimmten Grad der Zersetzung des Saftes im Holz, der sich durch einen unangenehm säuerlich-gärigen Geruch kenntlich macht. Frisch geschlagenes Holz wird vom Käfer nicht belegt. Für Eichenholz konnte festgestellt werden, dass Stämme, die nach dem 30. Januar geschlagen worden waren, im nächsten Frühjahr noch nicht von den Käfern angeflogen wurden. Unter Umständen können diese jedoch im darauffolgenden Frühjahr belegt werden, vorausgesetzt, dass sie nicht zu trocken lagertern und ihre Rinde in der Zwischenzeit nicht von Bockkäfern oder Buprestiden zerstört wurde.

Für die Praxis ergeben sich aus dem oben Gesagten die folgenden Hinweise: Eichen-Stämme aus dem frühen Wintereinschlag sind in der nächsten Flugzeit des *Hylecoetus* gefährdet und müssen vorher abgefahren oder durch geeignete Mittel geschützt werden, falls die Abfuhr nicht möglicht ist. Stämme aus dem späteren Einschlag sind weniger gefährdet, müssen aber vor der übernächsten Flugzeit des Käfers abgefahren oder geschützt werden.

Eine Bekämpfung der Larven im Holz ist, wenn Befall festgestellt wurde, in jedem Falle anzuraten, da die Larven unter Umständen zwei Jahre lang fressen und den Schaden vergrössern können.

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SECTION X

TROPICAL AGRICULTURAL ENTOMOLOGY

SAFFLOWER - PESTS IN ISRAEL

by
H. BYTINSKI – SALZ
Tel Aviv, Israel

The safflower (Carthamus tinctorius L.) is a crop of very ancient origin. It is already mentioned in the Talmud under the name of ,,Chariya", and today it is cultivated throughout the Islamic world for its colouring properties and is used in a similar way as saffron to tinge pastry and rice. Only in recent years has it taken its place as an oil crop and after a few years of extensive cultivation in Israel, taking up in 1950 an area of more than 4000 acres, coming directly after sunflower cultivation in importance. The safflower is an annual composite growing from 50–80 cm high and is cultivated as a summer crop without fertilizers, usually before next year's cereals. It accommodates itself to inferior (stony) and relatively dry (steppe) soil, and still gives yields of about 200 kg per acre in places where no other unirrigated oil crop is possible. As it is susceptible to cold, it is sown only in February, it flowers in June and is harvested in August-September with the combined harvester (an additional advantage).

Carthamus tinctorius belongs to the thistle group of Compositae, of which other genera like Cirsium, Carthamus, Notobasis, Carduus, Scolymus, Lactuca etc. form the main weed flora in summertime. A large number of insects belonging to this ,,thistlebiocoenosis" migrated in recent years into adjacent safflower fields, where some of them developed into serious pests. As most of these weeds start developing directly after the first rains in November and therefore bloom before the flowering time of the safflower, such pests as Lepidoptera and Trypetidae, which have several annual generations, first build up their population in wild species before attacking safflower heads. Only one generation is able to do damage, as the leaves and seeds soon become too dry for attack. Later generations of the pests however may develop on late flowering Compositae as f.e. in Lactuca.

All parts of the plants are attacked by pests:

Roots: Larvae of *Agapanthia (Col. Cerambycidae)* have been found occasionally boring in the root collar and the main root, and *A. cardui* L. and *A. dahli* Richt. have occasionally been swept from the plants in April. As in weeds, infestation does not hinder normal growth.

Stalk: The stalk is attacked in March by *Lixus speciosus* Mill., the larva of which causes a gall-like swelling of the stem. The beetle hatches in May-June and there probably aestivates and hibernates. If the gal develops high up, there is almost no disturbance in the growth of the branching flower stalks, but if the gall sits low it leads to a distortion in the growth of the side branches which results in a deminution in the number of lateral flowers with a corresponding loss of seeds. Sometimes 2–3 galls are found on the

same plant. *Lixus* has so far been found only in 1950 in 4 places. Then range of infestation was from 0.5%–15.3%, with an average of 8.2%.

Leaves: Among leaf pests *Pyrameis cardui* L. and *Plusia gamma* L. have so far been of minor importance, but must be regarded as potential pests. In 1950 a very heavy attack of *Chloridea (Lep. Noctuidae)* occurred all over the country in March-April. All four species known from Israel, listed according to their abundance, were found: *C.peltigera* Schiff., *C.obsoleta* F. with its *f.rufa* Warr., *C.nubigera* H.Sch. and rarely *C.dipsacea* L. In older plants they were doing less damage to the leaves, but bored into the young flower buds, the outer leaves of which developed normally, but the heads afterwards proved empty. In fields sown late, young plants of 5–10 cm height could be completely defoliated and be killed outright. The loss of seeds in 7 samples amounted from 14% to 91%, averaging 34,3%. Late in the season the larvae were killed in the field and the laboratory by a bacterial disease which completely checked the outbreak; the second generation in June was decidedly below normal.

Among other defoliators, the Chrysomelid beetle *Cassida palaestina* Rche should be mentioned, the larva of which eats round holes into the leaves of the ground rosette in March, but the plants usually recover. Severe damage by *Cassida* like that in the beets, where leaves may be defoliated up to the midrib, has never been observed.

Flowers: Haplothrips sp. was occasionally observed in the flower heads. *Trichodes quadroguttatus* Ad. (Col. Cleridae), *Mylabris sanguinolenta* Ol. (Col. Meloidae), *M.goryi* Mars., *Cteniopus gibbosus* Bdi (Col. Alleculidae), *Haplocnemus sanctus* Pic (Col. Dasytidae) and *Dasytes delagrangei* Pic are not uncommon on flowers in May-June were they feed chiefly on petals and pollen. They seem to be of minor economic importance.

Seeds: Most important are the pests destroying the young seeds. They were present in all 22 samples coming from 18 different localities throughout the whole country and the percentage of infested heads varied from 16 to 84.8, average 57.9%. The total loss due to all seed pests amounted to 47.8% + 3 m ∓9.3%, which means, that the infested heads produced only about half the number of seeds (13.45 ∓ 1.42 seeds per head) as sound ones (25.8 ∓ 1.56). Figure 1 gives the number of seeds in groups of 5 in healthy and infested plants and also the damage according to the different groups of insects. Among them are: Lepidoptera: *Porphyrinia parva* Hbn, *Myelois cribrella* Hbn; Coleoptera: *Larinus grisescens* Schönh., *L.syriacus* Gyll., *L. ovaliformis* Cap., *L.orientalis* Cap. and *Lasioderma serricorne* F.; Diptera (Trypetidae): *Acanthophilus helianthi* Beck., *Chaetorellia jaceae* R.D., *Orellia colon* ab. *wenigeri* Meig., *Trypaena stellata* Fuessly and *T.augur* Frfld.

The different kinds of pests can be distinguished by their damage in the following way:

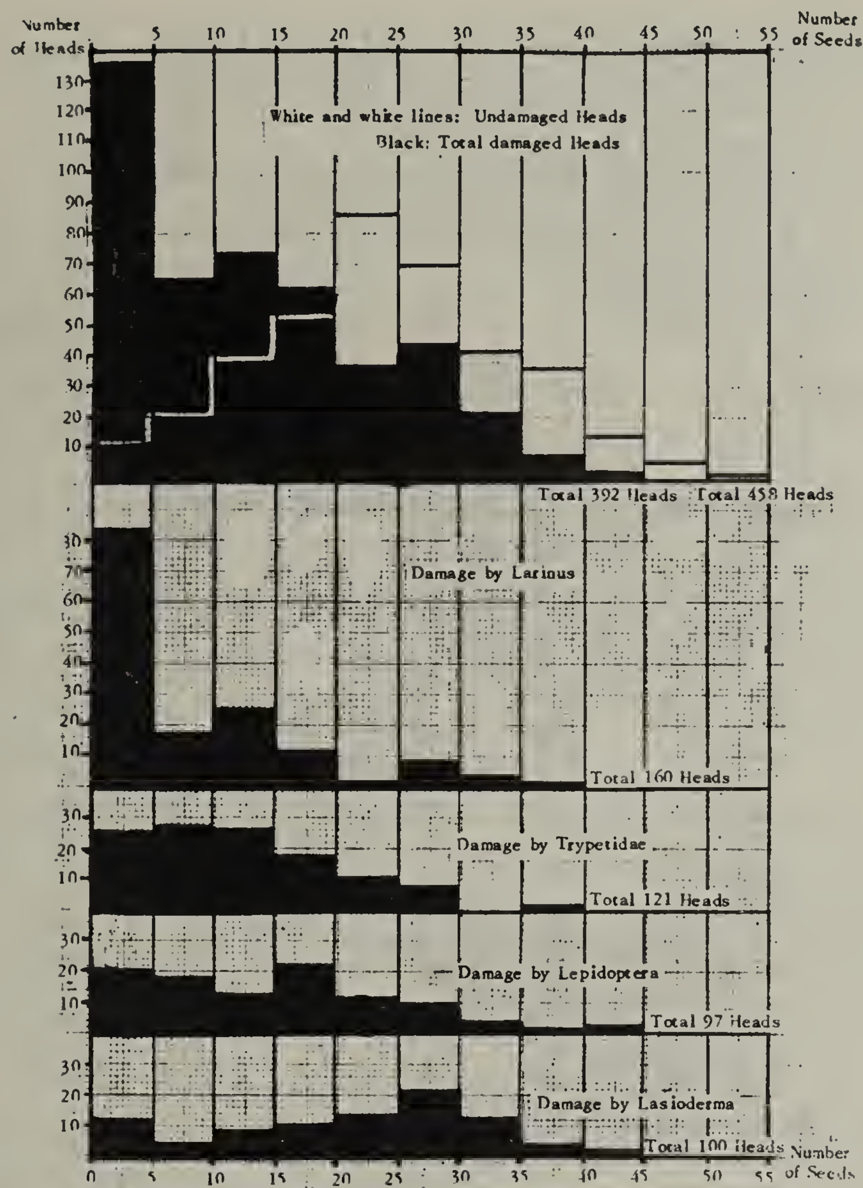


Fig. 1

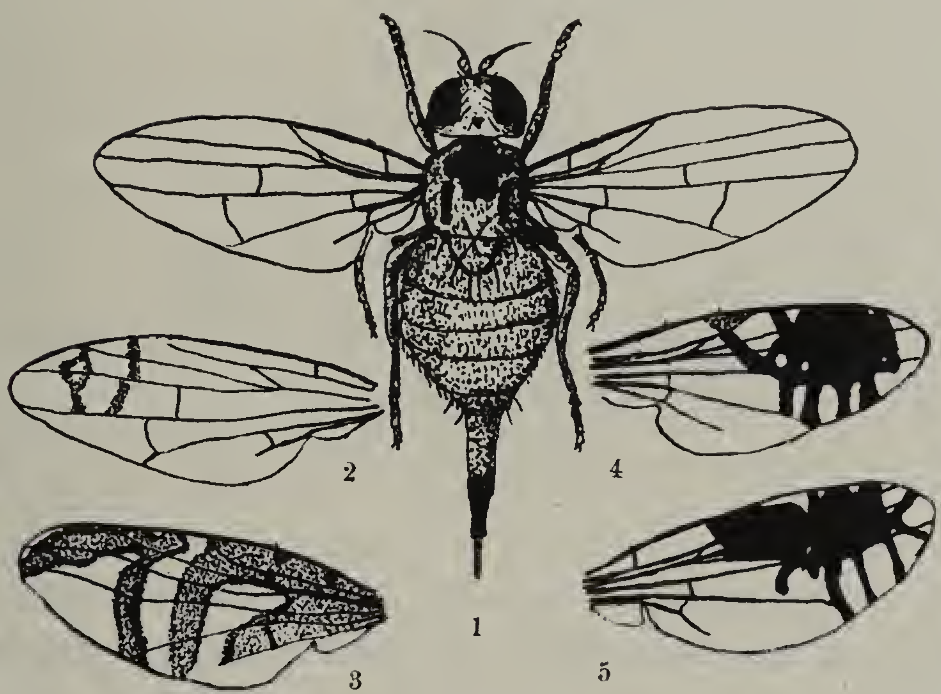


Fig. 2

1. *Orellia colon* ab. *wenigeri* Mg.
2. *Acanthophilus helianthi* Beck.
3. *Chaetorellia jaceae* R.D.
4. *Trypaena stellata* Fuess.
5. *Trypaena augur* Frfld.

1	Side of the dry flower head without or with circular hole of more than 5 mm width. Inside an empty cavity of about 10 mm with smooth bottom. Either all or the majority of seeds lacking. In a few seeds a large circular hole or most of the seeds eaten up. If the beetles have emerged, remains of larval and pupal skins present.	*Larinus*
	Holes, if present, less than 3 mm wide. No large cavity inside	2
2	Seeds eaten up on one side or almost entirely. Hole in the seed not circular but irregularly shaped. Empty seeds filled with brown larval excrements	*Lepidoptera*
	a Very often the brown naked pupal case, 4–6 mm long, found between the dried up flowers and hairs	*Porphyrinia*
	b Occasionally the brown pupal case, 8–10 mm long in a white silken cocoon, attached to the top or the side of the flower head	*Myelois*
	Seeds with smaller or larger circular holes, rarely completely eaten	3
3	Almost always on the side, where the seeds are eaten up, one or several empty dipteral pupal cases attached to damaged seeds or flower hairs. No exit holes on the outside	*Trypetidae*
	a Pupal case black, long and narrow	*Acanthophilus*
	b Pupal case amber yellow, short and broad	*Chaetorellia*, *Orellia*
	Exit holes, if present, $\frac{1}{2}$–3 mm wide	4
	Exit hole, if present, 1 mm wide, seeds with circular holes of 1–2 mm wide. Bottom of the flower head mined irregularly with 1–3 mm broad furrows in which small black excrements are present	*Lasioderma*
	Exit holes $\frac{1}{2}$–3 mm wide; all other characters of damage mentioned above may be present	*Hymenopterous parasites*

Porphyrinia is rather abundant occurring in 18 samples while *Myelois* is is rare (4 samples). Only one larva is usually found in one head. By both moths 7.5 – 40.0%, average 18.8%, of the flowers attacked; the total damage was 40.0 ∓ 3.78%.

Larinus infests the flower buds as early as April and finishes its development in August. More than 80% of the beetles remain in the seed heads after hardening of the body, even if they sometimes gnaw an exit hole. In this form they aestivate and hibernate. In the laboratory living beetles were found as late as March in heads collected in August. During threshing operations most of the beetles remaining in the flower heads are killed. The

most common species *L.grisescens* prefers smaller flowers which it often eats quite empty. This can be seen well in the great number of heads with 1–5 seeds only (Fig. 1). *L.syriacus* is usually found in medium or large sized heads. *L.orientalis* and *L.ovaliformis* were only occasionally found. This is interesting, as *L.ovaliformis* is by far the most common one of the smaller *L.* species on wild thistles. Also *Larinus* was found in 18 samples; the number of heads attacked was between 4% and 80%, average 19.6% and the damage to the seeds 60.2% ∓ 6.18%. This shows that, though the number of heads attacked is rather low, the total damage proved to be the highest.

The different species of *Trypetidae* can easily be distinguished by their wing patterns (Fig. 2). They show considerable variation in their quantitative and seasonal occurrence. Of all of them from 1–7 larva may develop in one seed head. They occurred in all 22 samples, though not all species in each one. The most common and widespread is *Acanthophilus* directly followed by *Chaetorellia*.

Trypaena stellata is still abundant and widely spread, while *Orellia* is local but may form the major pest in places where it occurs. *Trypaena augur* is local and uncommon. All species have at least 5 annual generations and emerge from the safflowers in July and August. *Chaetorellia* is the earliest to develop, while *Acanthophilus* usually occurs later in the season. Both of them are known in both earlier and later generations to attack wild and cultivated Lactuca flowers, where especially *Acanthophilus* is a serious pest in salad cultivation for seed production.

Lasioderma serricorne, the ,,tobacco beetle", develops in Israel not only in store houses, but also in the open, where it lives in dried vegetable matter. It is for instance especially common in empty Cynipid galls on oaks, but also develops in the flower heads of thistles and safflowers where it may occur in great numbers. It developed in 20 samples out of 22. Though from 2.5 – 49%, average 36.6%, of the heads were attacked the damage of the first generation resulting in an average less of 21.9% ∓ 4.8% of the seed production was relatively small. When the seed becomes too hard to be penetrated by the larva, the latter gnaw on the outside of the seedcoat giving it on the places attacked a characteristic dull appearance; the seed however remains viable. Though many beetles may leave the dried up flowers in July and August a further number of generations, up to 3, develop in the bottom of the flower head which they destroy completely by their burrowings and where they overwinter. They are moreover not killed by the threshing out of the seeds.

Control. All seed pests are parasitized, and so far some 12 species of parasitic Hymenoptera have been bred, among them: Bethylids, Ichneumonids, Braconids and Chalcidids. But so far their number has been too small to effectively control infestation in the field.

A brief mention of recommended means of control may be made here: Late sowing and harvesting as early as possible; burning of the remaining straw

after threshing and a rigorous elimination of all developing safflower plants from last years seeds on fallow land before flowering time. Experiments with dusting of Cryocide and Agrocide III just before bloom showed promising results, but must be carried out further on a larger scale.

DISCUSSION

Mr. **De Fluiter**: Are stored products a source of infection by the tobacco beetle in Palestine? They act as such in Indonesia.

Mr. **Bytinski-Salz**: Stored product are of no importance because the warehouses are always far away from the fields.

Mr. **Bodenheimer**: The tobacco beetle is here probably in its primary habitat: drying plants in the Middle East. Tobacco warehouses are a secondary biotope.

Mr. **Taylor**: I presume that the rather high damage recorded is due to the proximaty of wild hostplants especially Compositae.

Mr. **Bytinski-Salz**: Yes, thistles are the principal wild hostplants.

ESSAI DE LUTTE CONTRE LE „SHIMBU"

par
P. de FRANCQUEN
Gandajika, Congo Belge

Le „Shimbu" est un état pathologique qui résulte de l'association d'un coccide d'un genre voisin de *Guerniella,* de fourmis appartenant au genre *Camponotus* et d'un champignon, le *Macrophoma phaseoli* Maubl.

Les premiers résultats des essais de lutte, ainsi que l'étiologie probable de cet état pathologique, ont été exposés dans une note présentée en 1950 au Congrès scientifique organisé à Elisabethville par le Comité Spécial du Katanga.

Le „Shimbu" provoque de graves dégâts aux plantes spontanées et cultivées dans la région méridionale du Congo belge. Dans la région de Gandajika, les rendements du cotonnier et du maïs sont réduits de 20 à 30%. Les dégâts causés aux légumineuses sont moins importants.

Bien qu'il s'observe fréquemment sur la végétation spontanée,ce complexe morbide n'entraîne que rarement la mort des espèces sauvages.

Le „Shimbu" attaque le système radiculaire des plantes et spécialement la région du collet. Les fourmis colonisent la région envahie par les coccides. Ceux-ci provoquent par leurs piqûres, des formations chancreuses qui permettent aux agents pathogènes cryptogamiques, et spécialement *Macrophoma phaseoli,* de pénétrer dans les tissus végétaux. La présence du *Macrophoma* n'est pas nécessaire pour provoquer la mort de la plante attaquée. De jeunes sujets ou des plants d'espèces peu résistantes peuvent succomber à la suite du développement des formations chancreuses.

Avant l'établissement des cultures, le complexe pathologique se rencontre dans le sol à l'état latent et subsiste au détriment de l'Imperata ou d'autres plantes herbacées. L'aspect de la végétation naturelle permet de déceler la présence du „Shimbu".

Les essais d'isolement de *Macrophoma* réalisés à Gandajika par M.MOUREAU, Mycologiste de l'I.N.E.A.C., ont montré que le champignon n'est pas inoculé directement par les coccides.

Les essais de lutte réalisés en 1950 à l'aide de DD Shell, produit à base de dichloropropylène et de dichloropropane, ont donné d'excellents résultats. Ce composé est injecté dans le sol au moyen d'un pal injecteur. Le DD influence favorablement le développement végétatif du cotonnier et des haricots plantés en culture intercalaire.

Les essais, poursuivis en 1951, ont été scindés en trois groupes. Dans le premier groupe, nous avons étudié l'effet de rémanence du produit au cours de la culture suivante. Le second groupe avait pour but de vérifier l'action du DD sur le „Shimbu". Le troisième tendait à évaluer les augmentations de rendement dues à l'action stimulante éventuelle du DD.

1) Après culture cotonnière avec haricots intercalaires, une culture d'arachide fut établie dans un champ dont certaines parties avaient été traitées au DD. Les parcelles désinfectées sont restées pratiquement indemnes de „Shimbu". Nous avons cependant observé une certaine recrudescence des dégâts en bordure des taches. L'action bénéfique du produit sur la végétation était encore très manifeste. Dans les parcelles non traitées, le „Shimbu" a causé des dégâts aux mêmes emplacements.

2) Le deuxième groupe d'essais fut entrepris dans des plages supposées infectées et détectées par l'examen de la végétation. Six foyers importants avaient été délimités. Un semis préliminaire de cotonniers permit de vérifier nos suppositions et de déterminer l'importance et la répartition de la maladie. La levée eventuelle des semis a été relevée sur le terrain et reportée, poquet par poquet, sur graphiques. Les résultats montrent que les endroits infectés peuvent être déterminés par l'examen de la végétation naturelle.

Après extirpation des plants, les différents champs furent soumis à deux objets: témoin non traité et injection à l'aide de DD Shell à raison de 225 l à l'ha.

Le semis cotonnier définitif, exécuté 8 jours après la désinfection du sol, fut suivi de deux semis de remplacement. Les comptages à la levée furent également reportés sur graphiques.

Lorsque l'infection est moyenne, la levée est normale dans les parcelles traitées et les plants ne sont plus attaqués. Par contre, lorsque l'infection est sévère, on observe une recrudescence de la maladie. Dans ce cas, il est indispensable de traiter la totalité de la plage infectée et non pas de la diviser, comme dans le présent essai, en parcelles traitées voisinant avec des parties non désinfectées.

Au cours de cet essai, le développement végétatif des cotonniers des parcelles traitées a été nettement supérieur à celui des parcelles-témoin.

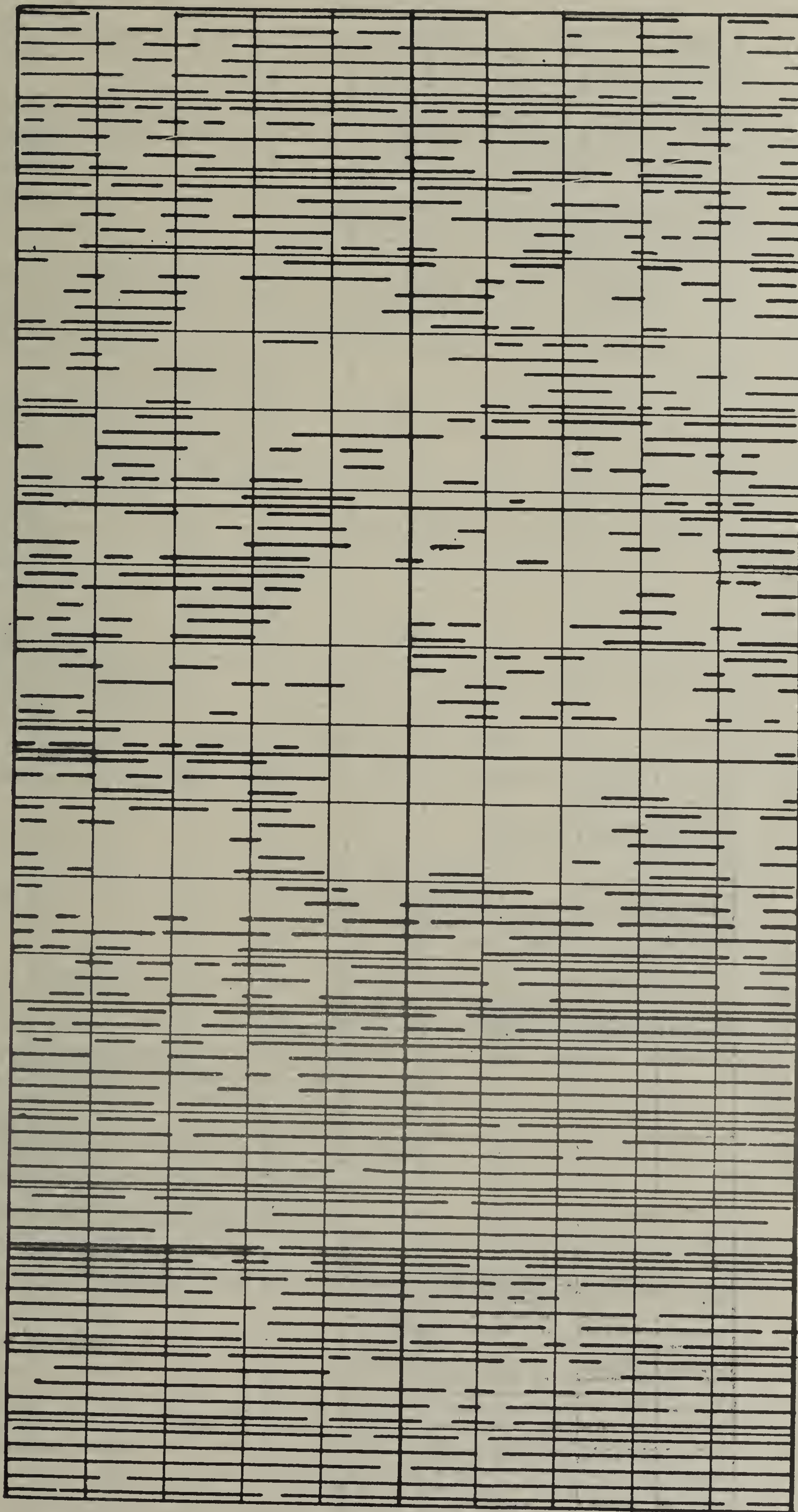
La récolte des différentes parcelles a été exécutée après élimination d'une bande de 1 m. Les taux de levée et les rendements obtenus sont rassemblés dans le Tableau 1.

3) La même répartition et le même traitement des parcelles ont été adoptés dans le troisième groupe d'essais. Les terrains choisis étaitent indemnes de „ Shimbu". L'expérience a porté sur une culture de maïs d'abord et de cotonniers ensuite. L'influence favorable du DD s'est manifestée dès la levée et s'est poursuivie pendant toute la durée de la végétation. Les plants des maïs et de cotonniers étaient plus vigoureux, plus élevés et plus productifs que dans les parcelles-témoin. Les % de levée et les rendements obtenus figurent dans le tableau II.

L'action stimulante du DD est donc significative sur le rendement moyen du maïs et sur le nombre moyen de carottes. Par contre, le poids moyen de la carotte n'a pas manifesté de différences significatives.

L'action du DD sur les rendements du cotonnier est encore plus marquée. Toutefois, ces différences de rendement peuvent être imputées à la tardiveté des semis cotonniers.

CHAMP I AVANT TRAITEMENT



100 m

40 m

CHAMP I APRES TRAITEMENT (6 PARCELLES)

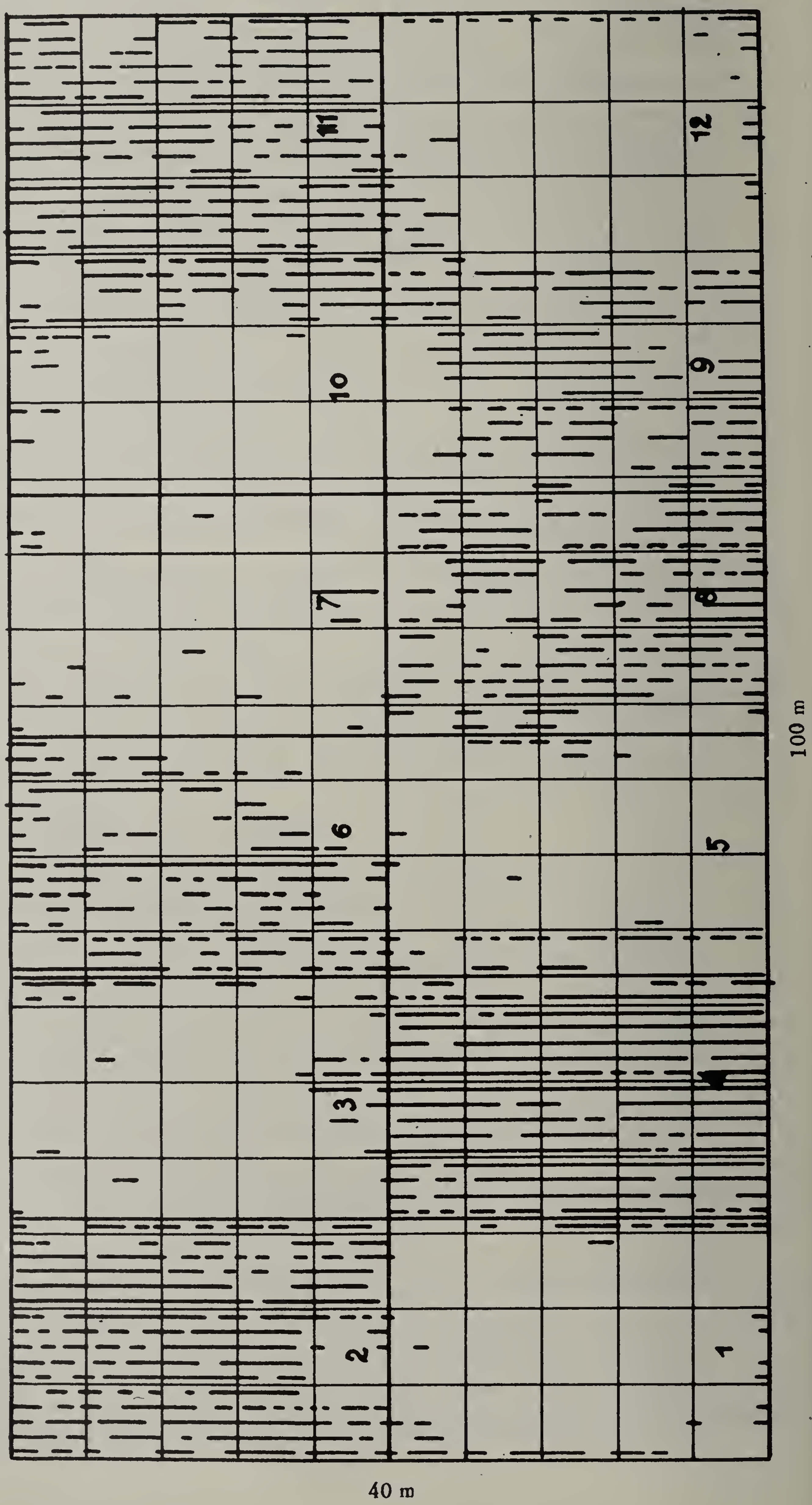


Tableau I

	Parcelles traitées		Témoins		
No	Poquets levés	Récolte en g	No	Poquets levés	Récolte en g
			Champ I		
1	633	8.575	2	121	50
3	625	10.625	4	63	225
5	561	16.650	6	245	11.375
7	618	17.200	8	166	8.000
10	535	11.625	9	216	11.200
12	556	14.850	11	138	3.425
Totaux	3.528	79.525		949	34.275
			Champ II		
1	430	éliminé	2	283	éliminé
4	439	9.125	3	357	4.950
Totaux	869	9.125		640	4.950
			Champ III		
1	292	9.750	2	242	5.025
4	275	8.025	3	178	5.650
Totaux	567	16.775		420	10.675
			Champ IV		
2	364	5.490	1	248	2.780
3	353	8.750	4	250	5.950
Totaux	717	14.240		498	8.730
			Champ V		
1	239	9.500	2	159	3.350
4	234	8.175	3	126	3.840
Totaux	473	17.675		285	7.190
			Champ VI		
1	481	15.500	2	378	9.750
4	451	17.550	3	271	3.950
Totaux	932	33.050		649	14.700
			Totaux des six champs		
en %	6.877	170.390		3.660	80.520
de T	171 %	212 %		100 %	100 %

Tableau II. — Action de l'injection de DD Shell sur la levée et le rendement des plants de mais et de cotonniers

	Mais		Cotonniers	
	Témoin	Traité	Témoin	Traité
Levée (poquets)	95,8 %	100 %	87,7 %	91,2 %
(plants)	84,7 %	93 %	56,7 %	62,9 %
Récolte (ha)	2.721 kg	3.215 kg + 494 kg	457 kg	647 kg +190 kg
en % de T.	100	118,1	100	141,5
Diff. sign. P. 0.01 : 634 kg 0.05: 429 kg 0.1 : 344 kg				
Poids moyen de la carotte Diff. non sign.	427.9 g	442.1 g		
Nombre de carottes	1916	2175 +259		
Diff. sign. P. 0,01 : 210				

DISCUSSION

Mr. **Gasser:** Comme agents du „Shimbu" vous indiquez différents fourmis, un coccide et un champignon. Le DD-Shell est-ce-qu'il est actif contre les trois types d'agents ou est-ce-qu'il est spécifique contre un d'eux.

Mr. **de Francquen:** Le DD est très actif sur les fourmis et les coccides. En ce qui concerne son action sur la Macrophoma nous croyons qu'il est actif mais également, nous n'avons pas encore pu le contrôler.

INVESTIGATIONS ON THE BIOLOGICAL CONTROL OF THE COTTON LEAF WORM, Prodenia litura IN EGYPT

I. Importance of local and foreign parasites.

by

Mohamed KAMAL

Alexandria, Egypt

The lack of a generally accepted method of artificial control and the continuous increase in the destructiveness of the insect, have stimulated my interest towards finding some means of subduing the annual undue increase of the pest. The author, therefore, has carefully studied and analysed the conditions under which the cotton worm survives in Egypt and in other countries. This was done in the hope to discover some factors that may help us to subdue the extreme increase of the population density of the pest during June to August.

Investigation of local conditions

During my studies which lasted a few years, I found that the role played by the indigenous natural enemies was much greater than anticipated. They proved to be very important factors, as they collectively were able to produce a decided reduction in the population of the pest amounting to approximately 35%. It has also been discovered, that the efficacy of the predators was much more superior than that of the parasites. The latter display rather greater activity in winter, particularly in clover fields, where in some cases the percentage of the host destroyed may reach an average of over 40%.

From the results obtained, it has been noted that the number of parasites attacking the cotton worm is rather small and their effect upon the host is insignificant, with the exception of the Tachinid flies *Tachina larvarum* and *Actia palpalis* which are considered of greater importance in reducing the population of overwintering larvae. The other species of parasites, such as *Trichogramma evanescens, Zele chlorophthalma*, and *Eulimnarium xanthostoma* are of too rare occurrence on *Prodenia* to be of practical value. Their collective efforts produce a kill averaging around 0.5 %. They scarcely affect the cotton worm at its peak of abundance in June and July, but appear late in the season to attack the smaller generations in late summer and fall. Against these small broods of the cotton worm no means of control are practiced, and the parasites might be very valuable herein. The last two species are primary parasites of *Laphygma* and *Agrotis*.

Since the great bulk of the local natural enemies do not start their activities except after the cotton worm has already done serious damages to the cotton, and since their number and reproductive potential are by far below that of the pest, it is, therefore, most feasible to resort to the other alternative, the introduction of new parasites from foreign countries to combat the undue abundance of the pest.

The introduction of foreign parasites

To carry out this project a plan of work has been designed by the author with an objective to introduce into Egypt as many species of parasites to each stage of the host insect as possible, and then to try to acclimatize them under the most favourable climatic conditions.

Two egg parasite species were imported from Suba (Fiji islands) and Java (Indonesia), namely *Telenomus nawai* and *T. spodopterae*. Moreover, two very efficient parasites on young larvae, namely *Microplitis demolitor* and *Actia nigritula*, have been received from Australia.

Results achieved

The breeding work of both introduced egg parasites has progressed successfully to the extent that it has been possible to liberate large colonies of them. The total number of the two species released amounted almost to five million individuals. The parasites were able to destroy about 80% of the egg clusters when released directly over the eggs in the field, and about 10% only when they were distributed haphazardly over the infested area. As far as establishment is concerned, the parasites were recovered from field specimens in several occasions in the same season, but I am not in a position yet to pass any final judgement about this question.

With respect to the two larval parasites, it was not possible to breed the tachinid in the laboratory and the few numbers received were liberated in the field. In the case of *Microplitis*, however, the condition was different, as we succeeded after several trials in developing a practical method for its propagation and were thus able to raise a considerable number for liberation in the field, though not large enough to warrant establishment as will be explained in a second paper.

The author is quite confident of the possibilities of achieving great promising results, as the cotton worm is the type of a pest for which biological control is best suited. The introduction of two more parasites, such as the dipterous *Winthemia quadripustulata* from America, and the braconid *Apanteles prodeniae* from India and Java which were found to be important factors of control against the cotton worm in those countries should be immediately attempted.

The establishment of faster and more frequent air transportations at present between Egypt and other respective countries will undoubtedly help to procure such quicker results.

Diseases of the cotton worm

The investigation of microorganisms associated with the cotton worm has been also given considerable importance by the writer. He found that the caterpillars under certain conditions of temperature and humidity are susceptible to a severe polyhedrosis which spreads as a scourge by killing almost all the population of the larvae in the laboratory. This virus, known as the rot disease, produces occasionally great reduction in field infestation by

the cotton worm especially in Northern Delta. Thus the disease promises to be of great practical value when means and practices are developed which enable us to include the artificial epizootics as a satisfactory method in our annual control program.

In such host complexes of parasites and disease the possibility of striking success may be quickly perceived. A combination of this kind has been responsible for the control of very many insects in other countries which might otherwise have assumed pest status.

Conclusion

The author wishes to emphasize the fact that quick results of such work should not be impatiently looked for. Numerous cases in biological control can be cited in which several years had elapsed before any positive results could be attained. It is generally known that once success by this method is achieved, it remains permanent and requires no further interference on the part of man, nor would it require any more efforts for renewal as we are often apt to do so with the use of insecticides.

It is hoped, therefore, that the biological control of the cotton worm in Egypt, the study of which has been initiated by the writer since 1938, will progress considerably and will evolve into an important permanent factor in saving our principal crop from the ravages of that abominable pest.

DISCUSSION

Mr. **Maher Ali**: 1) Is there any relation between the infestation and the ecological conditions, especially the "Khamasin" winds? 2) How can you guarantee that the introduced parasites will be promising, especially that there are terrific amounts of parasites and predators?

Mr. **Kamal**: 1) The hot dry winds blowing over Egypt in June and which are called the Khamasin, are no doubt of great value in reducing the population of the cotton worm in the egg and young larval stages. 2) This question has been dealt with in a rather lengthy form in a later publication by me, but I can say that there is no significant interference from particularly the local predators except the case of the eggparasites which are recently introduced into Egypt and have been found to be devoured by the local predators accidently as part of their food.

Mr. **Vayssière**: Est-ce-que dans ses recherches sur les parasites de *Prodenia litura* Mr. KAMAL a obtenu des précisions sur le pays d'origine de cette noctuelle et sur l'importance de ses parasites dans cette région?

Mr. **Kamal**: The origin of the genus *Prodenia* lies in the Central and Southern part of the United States with Mexico, New Mexico and Arizona as centres of distribution. It has spread westwards to the islands of the Pacific and South to Australia, Indonesia, the Malay and India and from the latter to Africa.

Mr. **Wolcott**: What is the first record of this insect in Egypt?

Mr. **Kamal**: The first record of the appearance of the cotton worm in Egypt runs about the year 1872.

INVESTIGATIONS ON THE BIOLOGICAL CONTROL OF THE COTTON LEAF WORM, Prodenia litura IN EGYPT

II. Techniques used in the introduction of Microplitis demolitor Wilk., a Braconid endoparasite of Prodenia

by

Mohamed KAMAL

Cairo, Egypt

Handling of host material

It was necessary to have an always available supply of *Prodenia* larvae at a stage suitable for parasitism at the time of parasite emergence. Therefore, several attempts have been made to hold *Prodenia* egg masses in cold storage at 12-14° C. When eggs were preserved in this way for 7-13 days, development was sufficiently retarded without appreciable mortality. All eggs subjected to the treatment for a few weeks were killed.

During the summer the difficulty of breeding *Prodenia* could be surmounted by the collection of additional stocks from the field. In winter, when this was not possible, another difficulty arose due to a virus disease infection which annihilated whole breeding stocks. The prevalence of this disease was the limiting factor in raising a large stock of *Microplitis* for field colonization. It was found that the virus disease kills the larvae when they are almost fully grown or nearly in the fifth instar, when a large number are closely confined for some time and when temperature drops as low as 20-23° C. Excellent control has been obtained by sterilizing all breeding containers and other material which comes in contact with the larvae. A 10% formalin is used for spraying the cages, while forceps, brushes, and jars are sterilized in alcohol repeatedly.

Nevertheless, to carry out massbreeding of *Prodenia* during the winter months with no casualities is not an easy task. It requires the heating of the host breeding compartment to maintain a temperature not less than 26° C, a constant vigilance on the caterpillars to check the spread of disease, and a great care for the pupae. *Prodenia* pupae stored in saw dust can be held for longer periods in cold storage better than larvae do. Accordingly, attempts have been made to store at weekly intervals a stock of these pupae to be available about the time of emergence of *Microplitis*. In this manner we are able to provide the breeding tests with young larvae at periods of great scarcity of host material.

Packing of consignments of the parasite

The best method for sending shipments of *Microplitis* from Australia proved to be the following one: Medium sized wooden boxes (8 x 5 x 4 inches) lined with white cloth were used. Parasite pupae were glued to narrow strips of blotting paper and placed seperately in a small tube constricted at the centre, which constriction was filled with cotton wool impregnated with queen honeybee candy as food. This was done in order to avoid the bogging of parasites in the food as well as the effect of "odor fatigue" on the part of the males (to be dealt with later on).

Feeding and longevity of the parasite

Adults kept in tubes in the laboratory were fed on small droplets of honey scattered along the midrib of an oleander leaf. Queen-bee candy has also been used with success. In the former case small cotton balls wet with water were used in the tubes to supply the insects with the required humidity, while in the latter the deliquescent surface of the food provided adequate moisture. Females fed in this manner were being kept alive for over seven weeks. This increased age is important as it gives us good vigorous females for parasitisation for a period of nearly three weeks. If the female is not used consecutively for oviposition she can remain fertile almost the whole period. In case of candy, it should be replaced as it becomes sticky to avoid the entanglement of the insects. Without food or water the maximum lifetime was only 8 days in summer and up to 15 days in winter.

Mating and sex ratio

In the early consignments received we noticed a preponderance of males. This was due to the faulty practice of allowing all available females to parasitize whether fertilized or not. The unfertilized females undoubtedly upset the sex balance in the total progeny with their male offspring. In breeding up to ten generations in the laboratory, it has been found that fertilized females gave raise to a progeny showing a sex balance favouring females.

Mating was at its best when one female and one male were placed in a small glass vial at a temperature of 29° C and humidity of about 55% and then exposed to strong sunlight for a short time. But when a large number of material was handled, the results obtained from the fifth generation were unsatisfactory resulting in an increased proportional number of males. The decrease in the number of fertile eggs was due, besides the increased number of unmated females, to the continuous breeding of the females for parasitization.

Odor fatigue

In breeding of *Microplitis* in captivity two phenomena were noticed. The first was that the males always issue before the females. Therefore, when one of the latter appears she was immediately mated by one of the anxiously

awaiting males. The second was that when a large number of cocoons of both sexes were placed in a multiple incubator for quick emergence, an increased number of infertile females were noticed.

From the results of numerous observations it is concluded that the female parasites apparently issue a sex odor which is attractive to the males in a rather light dose and causes them to respond immediately to copulation. When a large number of cocoons are allowed to emerge in a tube, the concentration of this odor causes that many males are quite unaware of the presence of females. This phenomenon is termed "odor fatigue".

If the period of contamination is not too long, the male is capable of recovering its sensitiveness to the female odor, especially if he is confined for a day or two in a separate container. When, however, males and females have been in close association for several days, it has been found impossible to mate them even after few days of solitary confinement.

Close association with males does not apparently affect the readiness with which females are apt to mate. Females accept the males readily if they are confined in a small tube and fresh males are admitted. It is noticed that males are able to fertilize more than one female and the latter are also mated more than once.

Oviposition of Microplitis and age of host

After mating each pair is transferred to a glass tube (5 x 1.5 inch) containing a small batch (50) of first instar *Prodenia* larvae on a cotton leaf. Food and water to the adult parasites are offered in the usual manner already described, and finally a muslin cover is held over the mouth of the tube by a rubber band. After an exposure of 12 to 24 hours to the parasites, the host material is transferred to a clean tube containing fresh food.

Prodenia larvae are watched carefully for four days for the nonparasitized ones, which should be removed and added to the host stock for breeding purposes.

The process of oviposition by *Microplitis* causes violent reaction to the host larvae. Caterpillars confined with the female parasites should be removed within a reasonable number of hours, otherwise they are weakened by consistent puncturing of their skin which makes them susceptible to disease attack. Young larvae about 3-5 days old are prefered for oviposition. The parasite occasionally displays some choice for larvae in the cluster stage or for those up to one week old. Later stages are not accepted regardless of the several attempts made by the writer in this respect. This factor has a very significant bearing on the economic importance of the parasite as will be explained later.

Completion and duration of life cycle

When fully mature the parasite larva pierces the host skin and forms a cocoon at the posterior end of the caterpillar. Only one parasite issues per larva.

Normally the parasite larvae emerge from the host leaving it in a dying condition. Sometimes, however, the caterpillar retains sufficient vitality to kill the cocooning parasite larva. This was found to be the explanation for several cases in which *Microplitis* cocoons were destroyed in the breeding containers for no apparent reasons.

The life cycle of the parasite varies from 9-15 days in summer and fall (with a minimum period of 7 days). In winter the cycle may extent up to seven weeks depending on temperature. In the spring it varies from 3-5 weeks.

Overwintering of Microplitis

Observations here and in Australia in particular indicate that with the advent of winter an increasing proportion of cocoons fail to yield adults at the normal time. Dissection revealed that many of the cocoons are viable containing the insect in the larval stage. Apparently the transformation into the pupa and then into the adult takes place immediately prior to the emergence of the adult. In one case in Australia reported by our collaborator, Miss ROBERTSON, the parasite spent five months within its cocoon.

Forced emergence by temperature and humidity

During July most of the laboratory breeding stock in Australia entered a diapause while it was necessary to forward a consignment of parasites to Egypt. For experimental purposes 117 cocoons apparently in the diapause condition were dispatched. On arrival 34% of the lot had broken their resting state. The passing of the airplane over tropical Indonesia, Malaya and India and then over the moderately hot climate of Egypt at the end of July has been the cause of breaking this diapause.

Consequently, an experiment was conducted on breaking the diapause by appropriate heat and humidity treatment. Five random lots of 10 cocoons each were subjected to the following treatments, while the sixth was retained as a check. The humidity in all cases was kept constant at 95% level.

1. Cocoons kept at 27° C during night, followed by 12° C at day.
2. " " " 5° C for one week and 27° C subsequently.
3. " " " 5° C for 7 days followed by 20° C.
4. " " " 27° C for one week followed by 19° C.
5. " " " 5° C for two weeks prior to gradual rise of 4° C daily.

In all cases adults of both sexes appeared, the emergence records of the cocoons being as follows:

Treatment:	1	2	3	4	5	untreated
Days elapsed before emergence:	5	5-7	5	10-11	8-9	8-9

The cocoons in treatment four required the longest time. About 50% had emerged at the eleventh day and no further emergence took place due presumably to sudden shocks caused by the rapid changes in temperatures. It was found unnecessary to reduce the temperature to 19° C as those maintained at 27° gave continuously adult insects. In some cases fungoid growth was observed, but it was not known whether this caused the death or accidentally grew on the insect dead bodies.

The quick success obtained in causing emergence of adult *Microplitis* parasites by high temperature and humidity would indicate that the resting phenomenon of this insect, to my opinion, could hardly be termed a true diapause.

Emergence from cocoons reared during the summer months can be held back by subjecting them to low temperature.

Possibilities of success of Microplitis in Egypt

Microplitis may be looked upon as the most suitable Australian parasite for introduction in view of the following advantages: 1) It is very prolific, for as many as 95 progeny were recovered from a single female. 2) It has a very short life cycle in the summer, as over two generations of the parasite correspond to one of the pest; this increases its chances of outnumbering its host. 3) It attacks the pest in the early stage of development, i.e. before it causes serious damage. 4) It can withstand low winter temperature. 5) It is easy to breed in the laboratory on a large scale so long as host material is available. 6) Its chances of success are enhanced by the gregarious habit of young *Prodenia* larvae; at that stage the controlling factor will be of great value in reducing potential outbreaks.

From experimental evidences brought out by the author in a previous publication (Bull. T. I. Soc. d'Entom. Egypt, 1951), the high mortality in the early larval stage of *Prodenia* together with the increased percentage of predatism in that stage, might perhaps be an important drawback for *Microplitis* to survive in the field, particularly in the first attempts of colonization when the numbers released are small.

Unfortunately, the numbers liberated so far were not large enough to ascertain the status of the parasite or predict its future acclimatization. However, some individuals were recovered from the sites of liberation and from localities some distance apart from the sites.

It is possible that, if strong colonies are liberated early in the season at the time when a heavy larval mortality is not apparent and population densities of *Prodenia* are high, the parasite species, being capable of rapid multiplication, may under such conditions become firmly established. A number of further tests should be tried before we are in a position to pass any judgement on the possibility of success or failure of the species under our environmental conditions. The record of *Microplitis* in other countries where the cotton worm exists is encouraging, therefore, its definite introduction is vitally important. To give the parasite a chance, additional importa-

tions are needed. Since a very closely related species has been collected by the author from Northern Delta region (near Alexandria) parasitizing the cotton worms, there seems no reason why the new species should not get established particularly in the North, where cotton worm infestation is always at its worst and environmental conditions are very favourable. The parasite may prove its value against the small generation of the cotton worm which attacks corn and early clover and is generally left untreated.

DISCUSSION

Mr. **Wolcott**: How far do the moths fly?

Mr. **Kamal**: By hops, 0.5 km.

Mr. **Taylor**: To what extent has *Microplitis* controlled *Prodenia* in Egypt?

Mr. **Kamal**: The answer to this question requires a much larger period of investigation than that devoted for studying the *Microplitis* in Egypt. In fact the work was only initiated at the worst times of the last world war; the continuity of the work was unfortunately impossible due to the engagement of Australia in the war, resulting in the suspension of our investigation on this problem.

CHEMICAL CONTROL OF THE COTTON LEAF WORM, PRODENIA LITURA L., IN EGYPT

by

Abd El Megid El MISTIKAWI
Cairo, Egypt

The Royal Agricultural Society started preliminary tests of modem insecticides against the cotton leaf worm in the years 1945-1947. Encouraged by the results obtained, another series of experiments was carried out in 1948 with the underlisted treatments. Each of the 12 treatments was replicated in 4 plots of 1/4 of a feddan each, bringing the total to 1 feddan (1.38 acres) for each treatment, and 12 feddans for the whole experiment. Although each plot was treated according to the schedule, only the central portion of each plot was considered when assessing the results, leaving a margin round each to avoid overlapping of different treatments.

1 :	10 % DDT	: dust
2 :	10 % DDT Wettable Powder	: 0,1 % spray
3 :	50 % DDT Wettable Powder	: 0,1 % spray
4 :	10 % DDT + 1 % Y of (BHC)	: dust
5 :	5 % DDT + 2 % Y of (BHC)	: dust
6 :	20 % BHC	: dust
7 :	15 % BHC + 5 % Sulphur	: dust
8 :	50 % BHC Wettable Powder	: 0,75 % spray
9 :	50 % DDD Wettable Powder	: 0,1 % spray
10 :	Nioka (BHC)	: dust
11 :	10 % Toxaphene	: dust
12 :	Hand picking (Control)	

The results of the experiments lead to the following conclusions:

1. DDT dusts and sprays, Dianol (DDD) & Toxaphene dust gave the best results. All BHC compounds either as sprays or dusts were less effective in killing the larvae of *Prodenia,* though it was noticed that it gave better results against Bollworms.

2. The plants treated with combinations including BHC showed more vigour, whereas those treated with DDT were shorter and ripened earlier.

3. Some treatments caused more boll shedding than others.

4. These factors had their effect in the total crop as well as in the ratio between 1st and 2nd pickings.

5. By using mixtures of DDT and BHC better results were obtained though the percentages of BHC in the mixtures tried were perhaps too low. It was, therefore expected, that with higher gamma content the results would be better. This was observed in following experiments.

In 1949 a series of 10 experiments on the same principles were carried

out, of which the following principal ones are mentioned:

1 : 10 % DDT	: dust	: 39.6 % kill
2 : 10 % DDT Wettable Powder	: 0.1 % spray	: 100 % „
3 : 10 % DDT + 3 % gamma of BHC	: dust	: 95 % „
4 : 5 % DDT + 3 % gamma + 40 % Sulp.	: dust	: 96.7 % „
5 : 50 % DDT Wettable Powder	: 0.1 % spray	: 100 % „
6 : 10 % Toxaphene	: dust	: 81.8 % „
7 : Hand picking (control)		: 18.8 % „

Results 1949

No. of Treatment	Height in cm	No. of flowers	No. of bolls	No. of open bolls	The 1st picking	2nd picking	Total crop in kantars per fed.
		per plant					
1	: 118.9	: 0.35	: 11.7	: 4.6	: 2.9	: 2.8	: 5.7
2	: 114.8	: 1.08	: 11.3	: 5.4	: 3.7	: 2.7	: 6.4
3	: 129.2	: 1.17	: 13.4	: 5	: 3.9	: 2.6	: 6.5
4	: 127.4	: 0.75	: 13.9	: 5.4	: 3.5	: 2.6	: 6.1
5	: 120.1	: 0.85	: 12.6	: 5.4	: 3.7	: 2.7	: 6.4
6	: 123.3	: 0.85	: 11.8	: 5.4	: 2.9	: 2.5	: 5.4
7	: 122	: 0.81	: 12.4	: 4.7	: 2.9	: 2.9	: 5.8

Comparing the results of the best two treatments 3 & 4 i.e. 10 % DDT + 3 % gamma BHC and 5 % DDT + 3 % gamma BHC + 40 % sulphur it was found that they were quite close to one another which meant that the addition of sulphur to the second had produced a certain effect, and it was therefore suggested that the addition of sulphur to the mixture with the higher DDT content would give a much better powder. The addition of sulphur would mean a slight difference of less than 5 % in cost price.

Finally in 1950 a fairly large scale experiment was carried out at various places in the Delta using only the new powder (10 % DDT + 3 % gamma BHC + 40 % sulphur). The results were everywhere spectacular. Larvae in all stages of development were killed within a few hours after the application. Moreover they stopped feeding almost immediately after contacting the powder.

Another great advantage was noticed in the effect of the dust on the infestation of boll worms (*Platyedra gossypiella*). After one treatment 33.7 % attack of *Platyedra* remained, after two treatments only 16 %, while untreated plots showed 49.1 % attack.

The crop was on the average about one kantar higher in dusted plots than in those from which egg masses were collected. Many other insects which frequent cotton fields were found dead eg. grasshoppers, bugs, thrips and beetles etc.

This work was published regularly in the annual reports of the Royal Agricultural Society and a special pamphlet resuming the results achieved

during the previous five years was published and circulated to attract the farmer's attention to the new method of control.

This present season (1951) about 5.000 tons of the mixture were supplied and still at a certain moment the quantity looked too small to meet all the demands.

It was tested on clover, maize, peas, vines and other crops and proved to have no bad results for the plants, when properly applied.

Cost of treatment

A. Hand picking of egg masses:

The usual practice is to appoint one operator per feddan daily for at least two months if the attack is normal and provided there is no third generation on cotton (August brood). In this last case, hand picking becomes tremendously expensive and the results in most cases are unsatisfactory for the difficulty of collecting all the egg masses from such advanced cotton. Invariably many eggs masses are left, and after hatching the emerging larvae produce a lot of damage and whatever is done by ordinary hand picking will not be enough to stop all damage. However, calculating for only one operator for 60 days 1 feddan costs 60 × 10 = P.T. 600 (L.E. 6).

B. Dusting expenses:

6 Kilos of dust at P.T. 25	P.T. 150 per treatment per feddan
Cost of labour (estimated)	P.T. 10 per treatment per feddan

Depreciation or hire of duster (est.)	P.T. 5	per treatment per feddan
Total cost of one treatment	P.T. 165	per treatment per feddan

The number of treatments should not exceed three, i.e. one treatment for each generation; if so, the maximum cost of chemical treatment would be P.T.495 (about £5.) per feddan, which is actually cheeper than hand picking of eggmasses. The price will certainly become much lower if the dust is manufactured locally.

It may be concluded that we now have a quite useful and reliable method to combat the cotton worm in its different stages, which during the past two seasons has proved its value. Having reached this stage, it would not be surprising to see a complete change in the methods of controlling the cotton worm in the near future.

It has been shown before, that clover is the most important source of infestation of cotton and other summer crops. The area of clover left for seed production is rather limited and the nature of the crop makes it much easier and more economic to control *Prodenia litura* in this crop than in cotton.

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DISCUSSION

Mr. **van der Laan**: 1) Old caterpillars of *Prodenia* have the habit of hiding in the soil just as cutworms do; then they cannot be reached by insecticides. 2) From many experiments on Noctuid-caterpillars in Indonesia it appeared that Toxaphene was slightly better than DDT, applied in the same concentration. 3) *Prodenia* in Indonesia is mainly a pest of tobacco, Arachis and beans, not of cotton, which is grown only on a small scale.

Mr. **Mistikawi**: 1) The old larvae come out to feed at night and during the cool hours of the evening and early morning; dusting is usually carried out during these hours. 2) Different insecticides give different results under different conditions and we all agree that research must still be continued, especially because new insecticides and combinations of insecticides are going on to be produced.

Mr. **Box**: *Prodenia* and several similar cotton pests also attack maize; these plants are quite unrelated. Is there a possible explanation for this very wide choice of foodplants?

Mr. **Mistikawi**: We noticed the same in *Prodenia litura* and some other

representatives of the same family. I made no special studies in this particular subject.

Mr. **Maher Ali**: I observed that the same larvae even attack the Casuarina and Citrus trees. We have to call it the "General Egyptian Crops-worm".

Mr. **De Francquen**: Quel est l'action du soufre dans le mélange DDT-BHC-S? Quelles sont les quantités et la periodicité optimales pour les traitements?

Mr. **Mistikawi**: The amount of dust per acre is 5-6 kilo's in young cotton and 7-8 kilo's later on. As regards the interval between two applications in the case of *Prodenia* one treatment for each generation is sufficient. The residual effect of the product extends over 2-3 weeks.

Mr. **Hosni**: Did you take any practical steps to control *Prodenia litura* before it leaves clover going to cotton?

Mr. **Mistikawi**: It is a problem under consideration.

Mr. **Betrem**: How large is the percentage of the *Prodenia*-population which is caught by hand-picking at different levels of population-density?

Mr. **Mistikawi**: When about 500-1000 egg clusters per acre are found we must collect them and continue to do so once every three days, which is the incubation period of the egg. If left to hatch, they cannot be easily controlled by handpicking.

THE TAXONOMY OF TERMITES AND ITS IMPORTANCE TO AGRICULTURE

by

J.E.WEBB

Ibadan, Nigeria

The object in presenting this short paper to the section for tropical agricultural entomology is to draw the attention of agricultural entomologists to some of the problems connected with the identification of termites.

It is generally believed that termites are of great importance in tropical agriculture, although in what respects it is sometimes difficult to define. Termites have achieved notoriety largely through the ability of some forms to feed on dry wood and the economic significance of their ravages in timbered buildings. There is an extensive literature dealing with these forms and with methods for their control. Yet it is by no means all termites that behave in this way. In most tropical and subtropical regions, termites are of almost ubiquitous occurrence and the majority of these cannot feed on dry wood, but attack plant materials which have already undergone some degree of decay or even the living plant. Harvester termites of the genera *Hodotermes* and *Trinervitermes* collect lengths of living grass leaves in their nests and denude huge areas of veldt in South Africa to such an extent that, where the land is also over grazed, serious erosion of the soil follows (NAUDE, 1934 and COATON, 1948). In Malaya, termites of the genus *Coptotermes* cause serious damage to rubber trees (PRATT, 1910) while *Microtermes pallidus* attacks tea (CORBETT and MILLER, 1936).

These are clear cases where termites are pests and there are many others. The majority of forms, however, feed on decaying vegetation and are among the most numerous of soil organisms. Nevertheless the relationship between termites and the soil constituents, both organic and inorganic, is obscure. One school of thought maintains that many termites are beneficial because they cause the rapid decay of wood and other plant tissues and thus add to the humus in the soil. Yet, as against this, the incorporation in the soil of humus from other sources, such as cattle droppings, may be interfered with by termites. In Northern Nigeria, and no doubt elsewhere, termites rapidly devour cattle excreta before it becomes mixed with the soil. The effects on soil humus content probably differs with the species of termite according to the feeding habit, but as ADAMSON (1943) points out, no precise quantitative data exists from which the effects can be evaluated and such casual observations that have been made are often contradictory and without reference to the species or even the genus of termite concerned.

It is held by some that the activity of termites leads to aeration of the soil and that their role in the tropics is similar to that of the earthworm in temperate regions (DRUMMOND, 1886). On the other hand, the mixing of soil

with body secretions and faeces in the formation of termitaria and earth tubes may be a factor leading to the compacting of soils in those regions where there is a prolonged dry season.

Only a few of the ways in which termites are or may be of importance to agriculture have been mentioned. There is a rich field for research in the study of termites, but we must first understand the taxonomy of the group before we can attempt to distinguish those forms of agricultural significance.

Apart from the American forms which have received most attention, the taxonomy of termites has tended to be neglected. Nevertheless, there is a substantial bibliography of the subject particularly from the economic point of view. At the present time, however, there are very few entomologists who can undertake identifications. This is partly because the group is so uniform morphologically that very few characters are listed upon which diagnosis can be based, and partly because it is so difficult to gather from the literature a satisfactory outline of the group that new workers tend to become discouraged by its complexity. Yet, if any progress is to be made toward an understanding of the role of termites in agriculture, we must be able to identify easily the species with which we are dealing.

At present, the classification of termites is based on characters which are largely relative, such as small differences in shape and size which are often difficult to interpret even by the worker experienced in the group. Moreover, the characters used are different for each of the castes within the colony. Thus, keys have been prepared for the identification of soldiers, others for workers and yet others for the alate forms. The differences between the castes are such that it is highly desirable that they should be treated separately where generic and specific determinations are concerned, but, when this procedure is carried into family determinations, it becomes increasingly difficult to obtain an overall picture of the group and even more difficult to carry out even rough determinations in the field.

There is, therefore, in the taxonomy of termites, a tendency for the colony as a whole to be ignored in favour of the individual insects of which it is composed. Yet the colony is an organic entity and should be regarded as such. As I see it, there is a real need for the termite colony to be investigated as a colony so that the characters of each type can be listed for purposes of identification. Experience in the field soon enables the entomologist to recognise the main types of termitarium without reference to the individuals within. This is done from an appreciation of the general facies of each type, but it still remains to analyse these into their constituent characters of importance and to list them for the benefit of those who have not had this experience.

The degree to which the characters of the termitarium can be used for identification probably varies from one group to another. In some cases they may be of use only in family determinations, but, in others, the differences in the form of the termitarium are much greater and more easily recognisable than the morphological differences between the termites themselves. In

Nigeria, two closely related species of the genus *Macrotermes,* separable only on the smallest characters in the laboratory, build distinct types of termitaria about which there can be no confusion. In one case, the termitarium is a low, rounded structure with lobular prominences, while, in the other, it is spire-like and rises to a height of 15-20 feet. These differences are largely external, for the general characters of the internal structure of the termitaria, such as the form and consistency of the galleries and fungus gardens and the position of these with regard to the queen chamber, are similar in both and show that the two types are closely related.

The form of the termitarium can be considered as a reflection of the physiology and behaviour of the insect, and therefore is a valuable taxonomic feature. As yet, however, we know very little about the effect of different environments on the termitarium, and it is probable, as HARRIS (1951) has stated with reference to some of the termites of East Africa, that it varies according to external conditions. Nevertheless, within variations so caused, it is to be expected that some of the differences and some of the similarities will remain constant. General characters such as these should be investigated more fully with a view to producing keys for identification which would be invaluable to the field worker.

In the same way it would be an advantage to know what morphological characters are shared by all or the majority of the castes within a species, and at the same time are characteristic of that species. At present it is difficult to identify isolated specimens such as the alate forms away from the context of the colony.

There exists an extensive taxonomic literature on termites, mostly dating from the first two decades of this century. An excellent bibliography by SNYDER (1949) gives reference to all the important works on the subject. The group, however, is badly in need of revision in the light of more modern views on systematics and particularly in relation to the ecology of termites. Until this is done, the subject is unlikely to make any very great progress.

There are so many problems of importance and interest awaiting attention in the study of termites and all of these, in some degree, are first dependent on a fresh taxonomic approach. Agricultural entomologists could do much to help by collecting data on the species within their area. Collections should be made of a generous sample of specimens of each caste within the colony and, if possible, the king and the queen should be taken. The internal arrangement of the termitarium should be described and the nature and position of the stores, such as lengths of chopped grass, and the presence or absence of fungus gardens noted. The collection should be accompanied by photographs of drawings of the external appearance of the termitarium and also its interior after it has been opened. Notes on the character of the galleries may be particularly important. Data on exact locality and also on the type of habitat is essential. Finally, many termitaria harbour inquilines of various kinds and it may be that the relationship between these and a particular species of termite is so close that they will provide an important subsidiary

means of identification. Inquilines, therefore, should also be collected.

We should aim to intergrate the work that has already been carried out on termites with fresh data on the ecology of the species and their distribution. When this has been done, it may well be that we shall have to revise our present concept of the species in termites.

This paper is intended to be provocative and, if it draws attention in agricultural circles to some of the problems awaiting solution, it will have served its purpose.

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DISCUSSION

Mrs. **Webb**: One of the difficulties of the taxonomy of termites lies in the fact that authorities differ over the identification of the genera.

Mr. **Lüscher**: This difficulty should now be eliminated to a large extent by the new excellent catalogue of the termites of the world by T.E.SNIJDER.

Mr. **Taylor**: Termites may, in general, be more beneficial than harmful, so far as agriculture is concerned. Examples are given. Urgent need is stressed for more specialists in termite taxonomy.

Mr. **Bodenheimer** points out the importance of termites as food. He further asks if the deficiency is not more one of taxonomists than of taxonomy.

Mr. **Webb**: The important point with regard to the taxonomy of termites appears to me the comparative neglect to date of ecological factors. It may well be that many of the species recognised to day may be variants of the same form from different environments and that when this is investigated many of the present species may be found to be synonymous.

Mr. **Noirot**: A propos de l'action des termites sur le sol je rappelle le cas de *Bellicositermes rex* n.sp. *) qui habite les savannes de l'Oubangui-Chari et du Cameroun (et probablement aussi du Congo) et dont les nids en dômes énormes (5 m de haut, 20-40 m de diamètres) modifient la topographie de la savanne. Comme les sols de ces régions sont latéritisés en surface, les termites remontent l'argile au dessus de la carapace latéritique et contribuent ainsi à la régénération du sol.

*) Grassé, P.P., Ch.Noirot: C.R.Ac.d.Sc., 1949.

THE PRESENT STATUS OF ECONOMIC ENTOMOLOGY IN PUERTO RICO (Summary)

by

George N. WOLCOTT

Rio Piedras, Puerto Rico

The greatest advances in the control of the insect pests of Puerto Rico are primarily due to the development of powerful new insecticides. These advances began with the popularization of DDT, but except in the household, DDT has a comparatively limited applicability in Puerto Rico, being most effective only against the pink bollworm of cotton, *Pectinophora gossypiella* Saunders, and a leafhopper, *Empoasca papayae* Oman, vector of the bunchy-top disease of papaya. Ever so much more important economically are the soil-inhabiting insects: white grubs, *Phyllophaga* spp., and vaquita grubs, *Diaprepes abbreviatus* L., attacking the roots of sugar-cane; the changa, *Scapteriscus vicinus* Scudder, the major pest of tobacco and vegetables; the coffee shade-tree ant or "hormiguilla", *Myrmelachista ramulorum* Wheeler; the fire ant or "hormiga brava", *Solenopsis geminata* F.; and subterranean and other termites, *Heterotermes convexinotatus* Snyder and *Nasutitermes costalis* Holmgren, all most effectively controlled by the chlorinated hydrocarbon insecticides chlordan and aldrin. Their effectiveness is symptomatic of the shift in emphasis from the insect to the insecticide. Against the dry-wood termite or "polilla", *Cryptotermes brevis* Walker, (which makes the cost of furniture in Puerto Rico twice what it is where this pests does not occur), the most minute amount of the natural constituent extracted from resistant woods, such as teak, mahogany and Scotch pine, can be used to impregnate susceptible woods making them immune to insect attack.

The application of life-history studies to pest control achieved conspicuous success when it showed that paring of the corms eliminates the banana root weevil, *Cosmopolites sordidus* Germar. Comparable investigation of the hosts of fruitflies showed that the two common local species are also present in southern Florida, making scientifically untenable quarantine restrictions on shipment of Puerto Rican fruit to continental markets.

Biological control also has its triumphs. Their very effectiveness, however, may unfortunately involve later outbreaks of the pest. The cottony cushion scale, *Icerya purchasi* Maskell, is again appearing after twenty years of too perfect control by local and introduced predators, parasites and the entomogenous fungus *Spicaria javanica*. The very need for chemical control of white grubs in recent years resulted from a combination of circumstances unfavourable for the giant Surinam toad, *Bufo marinus* L., an omnivorous predator that primarily fed on their adults, and had entirely eliminated them as a commercial pest in cane fields for nearly twenty years.

The introduced ladybeetles, *Cladis nitidula* F. from Trinidad, and *Chilocorus cacti* L. from Texas and Cuba, having an unrestricted diet of many more kinds of scale insects than those of bamboo for the control of which they were brought to Puerto Rico; have not only survived and dispersed widely, but the latter, apparently by its own efforts, invaded Mona Island and Hispaniola. The introduction from Brasil of *Larra americana* Saussure, a parasite of the changa, was a scientific success, but commercially of little value because the wasp did not disperse from sandy beaches to more valuable agricultural areas.

The introduction from the mountains of Hispaniola of a *Tiphia* wasp parasitic on white grubs, and of the numerous parasites of the sugar-cane moth-borer, *Diatraea saccharalis* F., from South America, resulted in not a single permanent establishment. A five year study of the normal incidence of the endemic egg-parasite, *Trichogramma minutum* Riley, indicates when releases of laboratory-reared wasps are most effective, but the moth-borer continues to be the major problem yet to be solved. Conclusive results are yet to be reported from the application in thirty-one plots of two and a half acres each at Central Cortada of a dozen different kinds of the new insecticides by overhead irrigation: a method uniquely effective in the dispersion of fertilizers and soil insecticides.

DISCUSSION

Mr. **Box**: Dr. WOLCOTT stated "*Diatraea saccharalis,* the sugarcane moth-borer, is not amenable to control". Is he aware that this insect had been completely controlled by imported parasites in the West Indian Islands? - Why did they spent 5 years on experiments with *Trichogramma* (which had been proven useless by entomologists of the USDA (VAYNES & BYNUM, 1942)) and neglect the method which had given proven results in other West Indian Islands?

Mr. **Kamal**: Have you noticed any competition among the introduced parasites and predators imported into the island, particularly with respect to the control of scale-insects and the sugarcane borer?

Mr. **Wolcott**: No.

OBSERVATIONS ON COCCINELLIDAE. I. COCCINELLIDS AS PREDATORS OF LEPIDOPTEROUS EGGS AND LARVAE IN VENEZUELA

by

Waclaw SZUMKOWSKI *)

Maracay, Venezuela

In the course of continuous laboratory and field studies made in Venezuela, chiefly at and near Maracay (Estado Aragua; alt. 460 meters), since August 1948, the effects have been examined of several species of Coccinellidae upon other insects, principally the immature stages of certain noxious Lepidoptera. This paper, however, relates only to *Coleomegilla maculata* ssp. *maculata* DeG. and *Cycloneda sanguinea* L. (hereinafter referred to by their respective generic names), which are the most common coccinellids occurring in the intensively cultivated area bordering Lake Valencia, where the field observations were mostly made.

It is well known that the larvae and adults of *Coleomegilla* and *Cycloneda* are at times voracious predators not only upon numerous aphids, other small Homoptera and such soft-bodied insects as Thrips, etc., but also upon eggs and larvae of other Coleoptera (including the coccinellid *Epilachna*) and those of certain moths, and there already exists a considerable literature on this subject, especially concerning the beetles as predators upon *Heliothis* in the U.S.A.

In the present investigation, a total of 1,150 separate tests have been made, using 280 individual coccinellid larvae or adults. The following species of Lepidoptera have been used in the laboratory experiments: Noctuidae: *Alabama argillacea* Hubn., *Feltia subterranea* F., *Laphygma frugiperda* S. & A., *Prodenia latifascia* Walk., *Agrotis repleta* Walk., *Sacadodes pyralis* Dyar; Pyralidae: *Diatraea lineolata* Walk. The experimental material was kept in small tins, 7.5 cm. diameter by 3.0 cm. deep, except when it was required to observe the beetles feeding, when standard-size Petri dishes were employed. In every case, daily observations were made to determine mortality due to the predators or other causes. The lepidopterous eggs were obtained by confining moths in oviposition jars, in which eggs were conveniently laid on strips of paper provided for the purpose, or sometimes on fresh leaves of the appropriate food-plant. It may be stated at once that there was no observable selection by the predators for eggs laid on the paper or those laid on the leaves. In some experiments, field-collected eggs were used. After hatching, fragments of leaves were provided as food for the caterpillars. As an essential part of the technique, in order to determine whether the lepidopterous diet was actually preferred or whether it was accepted only in the ab-

*) Communicated by H.E.BOX.

sence of more normal homopterous food, it was customary to use aphids (*A. gossypii* Glover, brought in daily from cotton fields) as "controls", and to separate the experiments in series, as follows: - (i) Lepidopterous eggs or larvae, in presence of abundant aphids; (ii) the same, with less aphids; (iii) the same, alone; and (iv) Aphids alone.

Experiments in the Laboratory

a) Using Lepidopterous Eggs. - Larvae and adults of *Coleomegilla* readily ate large numbers of the eggs of *Alabama* and *Feltia*, irrespective of whether aphids were present or not in the same containers, and in the case of *Alabama* they demonstrated a marked preference for its eggs even when aphids were present in abundance. Similar trials with *Cycloneda* showed that although eggs of *Alabama* were sometimes accepted, there was a very definite preference for the aphids.

In experiments with *Laphygma*, two kinds of egg-masses were distinguished, according to whether they retained their protective covering of hair-scales (hairy eggs) or were devoid of them (bare eggs). Larvae and adults of *Coleomegilla* always ate the bare eggs either in the presence or absence of aphids, but only rarely were the hairy egg-masses completely eaten, and then only by the adult beetles. *Cycloneda* always refused the hairy eggs of *Laphygma*, and would eat the bare eggs only when no alternative aphid diet was available. - The eggs of *Prodenia* are similarly deposited in masses with or without a protective covering of hair-scales. The results were the same as those obtained with *Laphygma*. - When *Agrotis* was tested, the adults and larvae of *Coleomegilla* showed a marked preference for the aphids. With *Sacadodes* so far only *Cycloneda* has been tested. The results were completely negative, the coccinellids refusing to eat the eggs even when no other food was available for them. - The eggs of the Pyralid, *Diatraea lineolata*, are oval and flat, laid overlapping one another in groups, in the manner of scales on a fish, and therefore they might be expected to offer more difficulty for the coccinellids. However, they were readily accepted, and in one experiment 41 eggs were eaten by one *Coleomegilla* larva in a day. They were refused by *Cycloneda*.

b) Using Lepidopterous Larvae. - In the experiments with lepidopterous eggs, *Coleomegilla* was a regular predator (except in experiments with *Sacadodes*), but *Cycloneda* clearly preferred to eat the aphids. When these same beetles were provided with young lepidopterous larvae of the same species used in the egg experiments, both of them accepted this food without reserve. In a total of 230 experiments the larvae (*Sacadodes* excluded from this series) were always eaten during their first or second instar, and recently-hatched larvae from large egg-masses of *Laphygma* and *Prodenia* were completely destroyed. In some cases more than a hundred postembryonic larvae were eaten by one individual predator.

Both coccinellids were shown capable of eating the caterpillars after these had reached their third and fourth instars, and in one instance a mature

Fig. 1. Larva (4th instar) of *Coleomegilla*, eating bare egg-mass of *Prodenia latifascia* (28/7/1950).
Fig. 2. Adult *Coleomegilla*, eating bare egg-mass of *Prodenia latifascia* (28/7/1950).
Fig. 3. Larva of *Cycloneda* (final instar and one day before pupation), eating large larva of *Alabama argillacea* on leaf of cotton (4/6/1949).

larva of *Cycloneda* fed upon a mature larva of *Alabama* many times its own size, almost completely sucking its contents.

c) Tests with *Dysdercus* showed negative results with their eggs, but first and second instar nymphs were readily killed and sucked by both species of coccinellids.

Field Observations

Field observations made in December 1948 by the author's colleagues, Messrs. L.A.SALAS and P.FENJVES, have confirmed that the hairy egg-masses of *Laphygma*, laid on leaves of maize, are occasionally eaten by *Coleomegilla*. Other observations made annually by the author, especially during the dry season (January-March), when maize can be successfully grown in the rich damp soils on the banks of Lake Valencia, have shown both *Coleomegilla* and *Cycloneda* to be abundant, independently of the presence of any kind of aphids. These conditions of maize cultivation in Venezuela are considered to favour the development of the first-generation outbreaks of *Laphygma* caterpillars, but such are quite unknown in this region, almost certainly because of the predatory action of the constantly-present coccinellids.

During the whole of the period of the investigation, the author has observed a definite correlation between the relative abundance of these two cocci-

nellids and that of *Alabama* in fields of cultivated cotton, even in the complete absence of aphids. This suggests that the beetles play an important role in combating the *Alabama* pest under field conditions, and further, stresses the possible danger of applying insecticides without taking this serious factor into account. The author believes that it might be practical to encourage or even to increase the populations of the coccinellids where cotton is grown on a large scale, by planting "reserves" of maize in the close vicinity.

It seems possible that the observed rarity of these coccinellids in those wide areas of orchard-savannah where the larvae of *Alabama argillacea* feed periodically (April-August) upon their wild food-plant, Hibiscus sulphureus H.B.K., in Venezuela, may be responsible for the survival of those vast numbers of moths which constitute the well-known migrations of *Alabama.*

OBSERVATIONS ON COCCINELLIDAE. II. EXPERIMENTAL REARING OF COLEOMEGILLA ON A NON-INSECT DIET

by
Waclaw SZUMKOWSKI
Maracay, Venezuela

During 1950, experiments were begun with the object of finding a type of food always available to enable *Coleomegilla* to be reared in large numbers. The larvae and adults were kept in paper cups (200 cc.) covered by small glass squares. Observations were made at least once daily.

The insects were at first given small pieces of fresh liver or raw meat alone, and certain interesting results were obtained with this food. Adult *Coleomegilla* fed voraciously on the meat, and the duration of the life of such individuals always exceeded that of (control) adults confined to a diet of aphids, frequently attaining more than 150 days (maximum observed 200), whereas in the controls the maximum duration of adult life was 125 days. The adults fed on meat, however, seemed always to be lethargic, and even although copulation was observed among them, the females failed to oviposit or when eggs were laid they were invariably in reduced numbers. Larvae of *Coleomegilla,* on the other hand, always died before reaching maturity when given a diet of meat alone. In one apparently exceptionel case, however, out of thirteen larvae kept together in a container, one finally reached the adult stage, but in this instance it had fed in cannibalistic manner upon the other larvae as well as upon the meat, a fact of considerable significance in the light of later experiments.

Looking for an explanation of the high larval mortality when meat alone was used, the experiments were repeated, using fresh meat with the addition of one, two or three live aphids daily, for each larva throughout its life. In

these cases 30%, 50% and 70%, respectively, of the larvae were reared successfully to the adult stage.

It was concluded that the meat alone lacked some substance necessary for the growth and development of the larvae, possibly a vitamin, which is present in the live aphids. A further series of experiments was begun, using fresh liver, which we know contains vitamins A, D, B^1, and C, and in 50 such tests an average of 38% of the larvae developed into adults. In other experiments the larvae were given fresh liver and meat with added vitamins, resulting in 86% with liver plus "Multivitamin Roche", and 93% with liver plus vitamin C. (The vitamins were prepared in the form of solutions, or rather emulsions, in various concentrations, mixing the food for some moments with the vitamins thus prepared, and also sometimes mixtures of the vitamins with egg-yolk or albumen were tried.) The quantity of vitamin C normally present in fresh liver alone seems to be insufficient for the larvae, and the unilateral addition of this vitamin is quite enough to produce the maximum percentage of development among them. In the meat experiments, where yet other vitamins were lacking, the unilateral addition of vitamin C alone gave no result, and there still was a mortality of 100% among the larvae, but by adding "Multivitamin Roche" there resulted 38% development to the adult

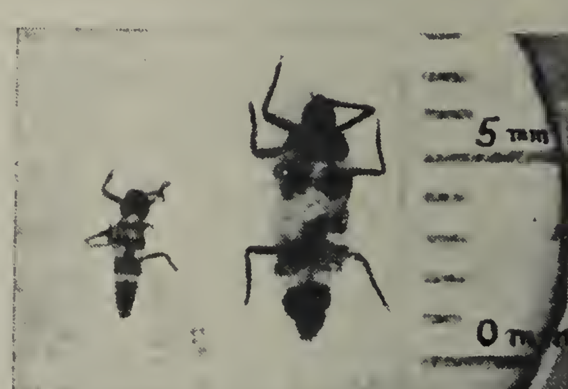
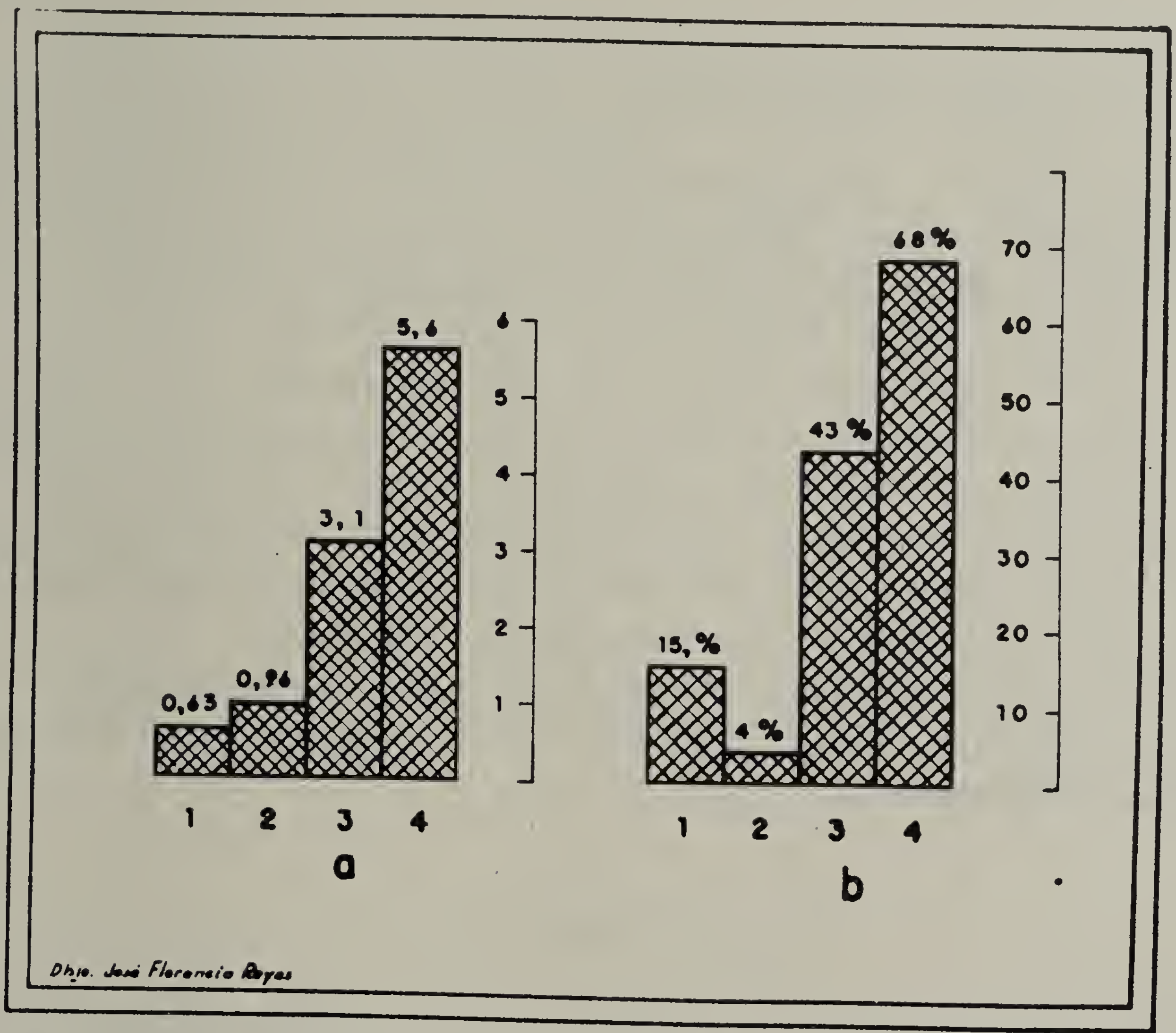


Fig. 1. Larvae (4th instar) of *Coleomegilla*, feeding upon fresh liver (23/7/1951).
Fig. 2. Adults of *Coleomegilla* eating fresh meat (23/7/1951).
Fig. 3. Two larvae of *Coleomegilla* from same batch of eggs, at the 19th day of their growth: Larva at left fed on fresh meat only; larva at right fed on fresh meat to which Multivitamin Roche was added (27/5/1951).

stage. In Fig. 3 are shown two larvae of *Coleomegilla* from the same batch of eggs at the 19th day of their growth; one of them has been fed exclusively

on fresh meat, and the other on fresh meat to which multivitamin Roche was added. These data leave no doubt that vitamins are absolutely indispensable for the growth and survival of these insects.

A further series of experiments was made to determine the influence of such diet upon oviposition. This particular research is not yet complete and the work continues, using fresh meat, liver and other foods, with and without the addition of vitamins and hormones. There are, however, some very interesting results already available, from tests using liver plus vitamin E, notably upon (a) the number of eggs laid, and (b) the percentage of these eggs hatching, and the results of four such experiments are now detailed:



1. Four females fed on *fresh meat alone* for a summed total of 360 days (no. of females x no. of days) of observation, deposited 261 eggs, with an average production of 261/360 =0.63 eggs per female per day; 15% of the eggs hatched into larvae.

2. Three females fed on *fresh liver alone* for a summed total of 170 days, deposited 163 eggs, with an average production of 163/170 =0.96 eggs per female per day; 4% of the eggs hatched into larvae.

3. Six females fed upon *liver plus vitamin E* for a summed total of 280 days, deposited 879 eggs, with an average production of 879/280 =3.1 eggs per female per day; 43% of the eggs hatched into larvae.

4. In other experiments with *liver plus vitamin E, with the addition of a small number of live aphids daily* (10 aphids for each adult pair of *Coleomegilla*), there was a very pronounced increase in the oviposition rate to an

average production of 5.6 eggs per female per day, and a corresponding increase in the percentage of eggs hatching, which reached 68%.

The last series (4) suggests that the aphids contain some substance which accelerates the rate of oviposition and increases the development of the eggs. The case mentioned earlier, when one larva given a diet of meat survived after it had fed in cannibal fashion on the other larvae in the same container, suggests that this substance, or another with similar properties, is not confined to the aphids. A knowledge of the nature of this substance is needed before we can replace it by an artificial medium.

Conclusion

Theoretically, the observed effects of certain foods, especially when they are used in addition to natural or prepared vitamins and possibly also other substances, upon (a) adult longevity, (b) oviposition, and (c) larval development, might help to explain various phenomena in insect life, such as seasonal fluctuations in their development, periods of diapause, and others.

Practically, we believe that a way has been found to produce unlimited numbers of the coccinellids under controlled conditions in the laboratory when they may be difficult to find in the field, our ultimate object being the biological control of certain pest insects. The results already obtained in these experiments show that it is practicable to rear the beetles in an artificial medium on a large scale without the aid of living aphids, but we are sure that the technique may yet be considerably improved.

Finally, the author emphasizes that this research is not finished and still continues at Maracay. The present note is to be regarded as no more than a preliminary announcement.

DISCUSSION

Mr. **Box** communicates that in Western Mexico he observed at Tepic, Nayarit, in March of the present year, a heavy deposition of *Laphygma* eggs on young maize plants heavily attacked by *Aphis maidis* Fitch. All stages of the local subspecies of *Coleomegilla maculata* were abundant, and several times their larvae were observed actually eating large hairy egg-masses of *Laphygma*. Judging by the number of recognisable scars left on the leaves where eggs had been laid, and the complete absence of any that had hatched normally, the mortality must have been extremely high, and it is noteworthy that in this region *Laphygma* is quite unknown as a pest of any importance.

Mr. **Kamal**: Has anyone bred or carried out experiments on Hymenoptera feeding on synthetic diets?

Mr. **Box** : I have experimented with the parasite *Pimpla roborator*. I was able to feed the parasite on chopped or hasted meat mixed with an extract of the pink boll-worm, *Platyedra gossypiella*. The parasite laid its eggs on this

material, when placed in a piece of corn-pith containing a groove. The material was covered with a piece of white paper perforated with a pin. The eggs were then removed and placed on pink boll-worm larvae partially killed with wet heat. With this method I was able to raise a large population of *Pimpla* at the time when there was a great shortage of *Platyedra*.

Mr. Kamal: Have you noticed any migration habits on the part of the Coccinellidae as it happens with some of our Coccinellidae in Egypt?

Mr. Box: Not in the sense you have in Egypt – only local movements from field to field or over short distances.

Mr. van der Vecht: For how many generations has it been possible to breed the Coccinellidae on non-insect diet? Was there no reduction in vitality in the course of time?

Mr. Box: I believe that Dr. SZUMKOWSKI has reared several consecutive generations on a non-insect diet, without noticeable effect on vitality. He is specially investigating this point.

Mr. Jepson: I have had considerable experience of rearing *Rhodolia cardinalis* on *Icerya seychellarum* in Mauritius and I found that after two generations the larval nutrition declined and the predator died out.

STALK BORERS OF TROPICAL CEREALS AND SUGAR CANE

by

W.F. JEPSON

Sunninghill, Berksh., England

Stalk borers of world graminaceous crops are mainly Lepidopterous, although members of the Diptera and Hymenoptera also occur as major pests. Familiar examples from the temperate regions are the European Corn Borer (*Pyrausta nubilalis* Hbn.) of the U.S.A. and Canada; the Frit Fly of oats (*Oscinella frit* L.) in Europe, and the Wheat Stem Sawfly (*Cephus cinctus* Norton.) in Canada.

I want today to draw attention to the chronic and serious problem of the Lepidopterous stem borers of cereals and sugar cane grown in the warmer regions of Asia, Africa and America. I will suggest that the essential unity of many of the problems involved demands a common approach. I hope to point out a number of lines of work which may point the way to better control of the Stalk Borers.

In general the crops concerned are maize, the sorghums and millets, rice and sugar cane. The pests are Pyralid moths of the genera *Diatraea, Proceras, Chilo, Scirpophaga* and *Schoenobius* and Noctuid moths of the genera *Sesamia* and *Busseola.*

Studies are in progress which should help to clarify the chaotic systematics of the Old World stalk borers. KAPUR has recently cleared up the synonomy of the Indian Crambines associated with sugar cane. In Africa, BOWDEN is achieving the desirable union of biological and systematic studies on the genus *Sesamia* in maize and millets. With the earlier work of BOX on the New World genus *Diatraea* and the constant association of W.H.T. TAMS of the British Museum with these investigations, good progress has been made towards a basis for an international assessment of stalk borers as a world problem.

The life history and mode of attack of these borers the world over, follows a common pattern, with variations in detail which require careful local studies to elucidate. The moths are inconspicuous, hiding by day, and laying eggs at night on the leaves of plants in all stages of growth. The young larvae on hatching, feed for a short time on the epidermal tissue of the leaves, and then bore into the stems where they feed during the whole of their development. The form of the damage and the symptoms of attack are typical of the species, and of the growth stage of the host plant. In young plants of sugar cane or maize for example, the central shoot may be killed by *Diatraea* or *Busseola* resulting in a brown "deadheart".

In rice, the yellowing and death of the young seedlings or transplants may take place in typical patches (straw hat damage) and one larva may wander through several shoots, in rice fields floating on the water surface to find another host plant.

Principal stalkborers of tropical cereals and sugar cane

Species	Common Name	Crop	Region
Eucosmidae			
Enarmonia schistaceana Sn.	Grey Stalk Borer	Sugar	China, Formosa, Philippines, Indonesia, Mauritius
*Pyralidae *)*			
Schoenobius bipunctifer Wlk. (Sch.incertellus Wlk.)	Yellow Stem Borer	Rice	India, S.E.Asia
Chilo suppressalis Wlk. (Ch.simplex Butl.) (Ch.oryzae Fl.)	Striped Stalk Borer Rice Chilo	Rice	India, Japan
Chilo zonellus Sn.	- - -	Rice,Maize, Sorghum, Sugar	India, Ceylon
Chilotraea infuscatellus Sn. (Schoen.infusc.; Ancylolomia sticticraspis Hmps.)	Yellow Shootborer	Sugar	India, Java
Proceras polychrysus Meyr. (Diatraea auricillia Dudg.)	Striped Stalk and Shootborer	Maize,Rice, Sugar	Malaya, Java, Bali
Proceras indicus Kapur	Spotted Borer	Sorghum, Sugar	India
Proceras sacchariphagus Boj. (Diatraea venosata Wlk.) (D.striatalis Sn.)	Spotted Borer Small Borer Moth	Sugar	Java, Mauritius, W.Indies, C. and S.America
Scirpophaga innotata Wlk.	Witte rijstboorder (White Stalkborer)	Rice	Indonesia, Philippines
Scirpophaga nivella intacta Sn.	Witte topboorder (White Topborer)	Sugar	Indonesia
Scirpophaga nivella Sn.	- - -	Sugar	India
Noctuidae			
Sesamia inferens Wlk.	Violet Stem Borer	Rice,Sugar, Millets	Asia
Sesamia cretica Led.	- - -	Sorghum	Sudan, Egypt
Sesamia calamistis Hmps.	Rice Borer	Rice,Maize, Millets	Africa
Sesamia vuteria Stoll	Pink Borer	Sugar, Maize	Morocco, Mauritius
Busseola fusca Hmps.	Maize Stalk Borer	Maize, Millets	Africa

*) Pyrausta nubilalis Hb. the European Corn borer, although not typically a tropical pest is of importance in Japan and Egypt, and a variety also occurs in Indonesia.

In older maturing plants, some species cause such weakening of the stem that wind breakage readily occurs. I have seen in Western Tanganyika larvae of *Busseola fusca* so numerous in maize as to inhibit the development of the flower head. In sugar cane, inversion of sucrose is a serious factor, and invasion by fungi is also promoted.

When mature, the larvae generally pupate in their own tunnels, and the seasonal carry-over may be serious where long stubbles are left in the ground.

In full tropical conditions the life cycle is about 40-50 days and there rarely appears to be a diapause. The borers must therefore find alternate hosts during the long dry season typical of Africa. Here lies an important and almost untouched line of field research for the future.

The estimation of crop loss is accompanied by so many pitfalls that exaggerated accounts, so frequent in the literature, have too often been discounted by those responsible for taking counter action against pests. Figures of 25,50 and even 75 per cent of "deadhearts" in young plantations, and of up to 80 per cent of mature plants attacked by borers are often quoted, leaving the reader with the idea that this represents a loss of crop of these amounts. In fact, in many areas, as in rice in Formosa, rapid tillering completely nullifies a heavy destruction of primary shoots by borers. In Africa however, a short critical growing season may fail to make up the time lost by the plant, especially maize, in putting forth new tillers. Apart therefore from individual fields which fail completely, the entomologist must be most conservative in attributing to stem borers more than a fair share of responsibility for loss of crop. It may be legitimate to point out that the borer *Sesamia calamistis* prevents the cultivation of a second crop of maize in Ashanti, or that famine has been caused in Kyushu (Japan) by *Schoenobius* in the rice crop. There is no doubt however, that global losses of grain or sugar in most countries should be expressed in single figures, and that 2% to 5% preventable loss by borers should be admitted and accepted as a serious challenge to the agricultural scientist.

It is in no way to minimise the necessity for action to associate this loss factor with others more familiar to the agriculturalist such as overseeding with poor varieties, lack of weeding, singling, manuring, each of which if they could be universally remedied would go far towards meeting food shortages.

Time does not permit any detailed reference to the life history and ecology of individual borers. But the foregoing list with names only too familiar to many of you, will help to indicate the extent of this world problem.

What are the lines upon which further work is urgently needed? It is normal for the entomological services in most areas to be familiar with the life history of their local borers and to have fair records of annual and seasonal fluctuations in their relation to weather and to existing agricultural practices. This knowledge has enabled a wide variety of cultural and other control measures to be developed. Close seasons, shifting of planting date, uprooting of stubbles, flooding, trapping of larvae, collection of eggs, have all

contributed with varying success to stalk borer control. Extensive work on biological control particularly in the New World is so well known as to require no elaboration here.

May I advance a few lines of research:

Entomological

1. Techniques of quantitative population estimation should be applied intensively to enable the course and causes of local population fluctuations to be determined and predicted.

2. The nature and status of alternate host grasses needs systematic study in a number of selected habitats e.g. in Africa, the White Maize Borer, *Busseola fusca,* may use Pennisetum, Elephant grass in one area and Panicum (Guinea grass) in another. The Asian rice borer, *Schoenobius,* on the other hand appears to have no alternate hosts. What therefore is their significance in promoting infestation.

3. The whole field of parasitism requires review and intensified local study. Ecological conditions favourable to the chief parasites should be defined to enable more co-ordinated and sustained trials to be done simultaneously in a number of different areas. The concept of ecological islands may be used to select parasites for trial in the varying conditions of climate and cropping found in large continents.

4. Physiological studies on the behaviour and nutrition of larval and adult stages of the borers may be valuable in explaining migration and host selection. In particular, characters favourable to host resistance may be pointed out to the plant breeder. We heard yesterday in Section 4 (Physiology) of the successful rearing of *Pyrausta nubilalis* on artificial media. A more extensive use of such techniques will contribute to our knowledge of the tropical borers.

Agricultural

1. The aggregation of cropping should be planned in order to enable alternate hosts to be eliminated and modern plant protection measures to be applied, e.g. to separate maize areas from fallows of elephant grass by a stretch of legumes may reduce borer incidence.

2. The introduction of mechanised land preparation should be studied in relation to stubble destruction, weed elimination, and the ensuring of timely planting and quick early growth, all of which undoubtedly affect borer damage. Considerable progress in this field has already been made in the British African Colonies by the operation of mobile tractor units.

Insecticidal

1. The happy co-operation of chemist and entomologist has borne fruit in the rapid advance of chemical plant protection. The use of chemicals in extensive crops such as cereals, in the generally primitive conditions of cultivation in the tropics is in its infancy.

Points which arose during my own experience of the borer problem in Mauritius and East Africa were (1) The successful use of hand dressings in the Union of South Africa with 1 to 2½% D.D.T. dusts in young maize against *Busseola* need to be enhanced for tropical conditions by research

into the adhesive and spreading properties of dusts. Heavy wash and difficulties of timing in peasant application are practical obstacles to be overcome.

2. The development of systemic insecticides or repellents is especially indicated to deal with the rapid evolution of plant tissue which at present grows rapidly away from any external insecticide treatment.

3. Precise work on the bioassay of stalk borer poisons is an absolute pre-requisite, leading to a series of specifications which might be issued as a guide for the field entomologist.

4. There is a tremendous, almost untouched field for the designer of robust simple machines for the small grower in the tropics.

There is a very definite gap to be filled between the beerbottle and cigarette tin on the one hand, and the conventional European machine, introducing the internal combustion engine and numerous fragile "gadgets" on the other.

5. In larger plantations, the development of combined weed and borer control sprays at low volume should proceed hand in hand.

In this field it is interesting that INGRAM, BYNUM & CHARPENTER working in Louisiana found that the use of 2-4-D in sugar-cane has been accompanied by a considerable increase in *Diatraea.*

If, as I believe, the stalk borer problem is recognised by Governments to be of serious importance in widespread areas of the world, the creation of a small international sub-committee might be a useful first step in determining the extent of the problems and in formulating proposals for common lines of work and exchange of information. I hope that this brief sketch of the stalk borer problems will serve as a basis of discussion.

DISCUSSION

Mr. **Box** observed that Mr. JEPSON uses the word "Maize" which is very much to be preferred in stead of "Corn" or "Indian Corn". He strongly supports Mr. JEPSONs plea for an international organisation to deal with the problem of moth borers in graminaceous plants.

Mr. **El Mistikawy**: We found in Egypt that 5% DDT was not strong enough to kill *Prodenia*-larvae at normal doses. The speaker said that by applying 2½% or even less, good results were obtained and we should like to hear some explanations.

Mr. **Jepson**: In maize the DDT is applied only to the funnel of the maize-plant and the weak concentration is able to kill the first stage borer larvae.

Mr. **Strickland**: 1) What is the correct common name for *Busseola fusca?* 2) Are there any methods for assessing populations and damage by borers which could be applied uniformly over a large scale?

Mr. **Jepson**: 1) I think it varies in East, South and West Africa; they call it white maize borer in South Africa and we call it maize stalk borer in East Africa. 2) This is a matter which BOWDEN is now tackling in the Gold Coast.

INTERRELATION AND INTERACTION OF BIOTIC AND ABIOTIC FACTORS IN SOME TROPICAL INSECTS

by

J.G. BETREM

Deventer, Holland.

In studying the alterations of an insect population we split up the influence of the total environment into the factors that determine the size of a population. Then we try to form an opinion as to which factors are of importance.

The influence of the separate factors is often considered to be independent of each other. This is certainly not the case. It must always be kept in mind that they form more or less an entity, of which the population of the species, we are interested in, is the centre; this we call the biological complex.

By breaking up this entity, we lose a part of the available information. It is possible for each of two factors working separately to have no appreciable influence on the population density; while working together their influence can be very great. In agriculture this phenomenon is called interaction.

A discussion as to whether the abiotic factors are generally of greater importance than the biotic factors can not lead to definite results, because the interrelation and the interaction between these factors is of too great importance, as will be shown by some examples.

1. *Shot-hole borer of coffee (Xyleborus morigerus* Bldf. and X. *morstatti* Hag.) In Indonesia most of the smaller branches of the coffee tree are infected by these beetles. Like all *Xyleborus* species, the larvae and the adults are ambrosia feeders. This fungus grows on the walls of the galleries that are bored by the beetle in the centre of the younger branches. During the dry season new galleries with ambrosia fungus and larvae can only be found occasionally. During the wet season, however, the ambrosia grows abundantly on the walls. Then the larvae and the adults have plenty of food and therefore the population grows. In consequence the size of the beetle population is apparently dependent on the rainfall (BEGEMAN, BETREM). The rain can, however, exert its influence only through the coffee plant and the fungus. In this series: rainfall, coffee, fungus, beetle, the coffee is especially important. A more intensive examination has shown, that not all younger branches of the coffee tree were suitable for the growth of the ambrosia, not even during the wet season. In branches that are completely healthy the ambrosia can not grow; it flourishes only in those that are more or less weakened; e.g. twigs of trees of which the roots are attacked by eelworms *(Pratylenchus pratensis* (de Mann) (= *Tylenchus coffeae* Zimm.), *Rotylenchus similis* (Cobb)) are especially severely infected by the beetle. Sometimes more than five holes are found in each internode. The eelworms cause a scarcety of water in the plant. At first sight this seems in contradiction to the fact that the ambrosia does not grow on the coffee wood during the dry season. Physiologically, however, we have here two different influences.

Statistical studies have shown, that the only branches heavily attacked are those that are weakened and would in any case die by natural causes in a short time. The *Xyleborus* beetles are therefore secondary pests of the coffee. From this it is clear, that we can not consider the influence of the rainfall on the population density separately from the physiological condition of the plant and the growth of the ambrosia fungus.

Above mentioned results lead to some remarkable conclusions about the influence of the parasites of *Xyleborus* on its population density. The most common parasite is an undescribed *Tetrastichus* species *(Chalcidoidea)*. It can be seen from the following simple consideration that this chalcid can only control very rarely the shot-hole-beetle. The niches that are at the disposal of the young beetle will be always very limited, and often this number will be rather constant. The beetles that can not find branches that are suitable for the growth of the ambrosia fungus, must consequently die. This will be a rather large number, because on the average 13 beetle ♀♀ are found in each hole. If the parasite kills many beetle larvae, the only result will be, that less beetles die by lack of niches.

2. *Mosquito bug of cacao and tea (Helopeltis).*

Some particulars about the oecology of these bugs were already given at the Entomological Congress at Stockholm. During the dry season the population density is very low, but during the wet season it gets higher and higher. This is not the case in all gardens and on all trees. In many of these the density always remains low. The physiological condition of the tree, which here also forms the link between the rainfall and the bug, again appears to be of great importance; this will be illustrated by the following example.

In West Java, where only a short dry season exists, the *Helopeltis* is a very important pest of tea; in Central and East Java, with a long dry season, the *Helopeltis* is a great rarity on tea. With cacao, on the contrary, it is an important pest in the last mentioned regions.

Here again we find a correlation between the rainfall and the population density. In some cases this correlation will be high, in others it will be low, in proportion to the physiological condition of the trees. It is therefore hardly possible to consider these two factors separately.

3. *Coffee mealy bug (Pseudococcus citri Risso).*

The coffee mealy bug shows in some respects the same interrelations as the shot-hole borer and the *Helopeltis*. These coccids are abundant during the dry season and rare during the wet season, which is known of many other mealy bugs also. Again the coffee tree is the intermediary between the mealy bug and the rainfall. The physiological condition of the tree is of great importance too. This can be shown by the following examples. During the wet season much less honeydew is formed compared with the dry season. Coffee under heavy shadow is not so severely attacked by this coccid as is coffee under light shadow. DE FLUITER showed that this is not due (or not

only due) to a higher relative humidity of the air, but to another physiological condition of the plant. Furthermore this mealy bug can only live on the coffee shadow tree, "lamtoro" (Leucaena glauca) above 600 to 800 m above sealevel; below this altitude it is only very rarely found on this tree. The coccids of lamtoro do not belong to an other race, as was demonstrated by BETREM, and later on confirmed by experiments by DE FLUITER.

There are still more complications concerning the epidemiology of the mealy bug of coffee. In the first place there is an important entomophagous fungus (Empusa Fresenii Nowak.), that can grow only if the relative humidity of the air, depending to some extent on the rainfall, is high enough. Therefore it is an important factor in the control of the mealy bug population during the wet season only. During the first weeks of this season the fungus reduces the very large mealy bug population, until only a fraction of the original is left. Later on the distribution of Empusa is very dependent on the density of the mealy bug population. The ants are yet another factor that complicates the epidemiology of this mealy bug. In Indonesia the most important ant is the "gramang" (*Anaplolepis longipes* Jerd.). If this ant attends the coccids the size of the population can get rather large even during the wet season. It is possible that there is some relation between the ants, the entomophagous fungus and the honey dew. By controlling the ants, we can keep down the mealy bug population during the wet season, so that as soon as the dry season begins, there is only a small population of coccids. Therefore the damage point for the coffee tree will be reached much later in the gardens where the ant has been controlled, than in those where it can attend the mealy bugs freely.

So with the mealy bug of the coffee, we have many interrelated factors. Computing simple correlation between the rainfall and the size of the coccid population can give very misleading results. Only with the help of the multiple correlation technique and by taking account of interactions between factors, can a sufficient insight of the importance of the different factors and their interrelations be obtained.

These examples suffice to show that it is very dangerous indeed to build conclusions on the study of single environment influences considered in isolation.

DISCUSSION

Mr. **W.G.Jepson**: Would Professor KAMAL contrast the conditions in Egypt and Java as affecting mealybug population?

Mr. **Kamal**: Mealybugs in Egypt are affected by temperature more than by any other factor. Humidity has undoubtedly to play a part in that the populations of mealybugs are very numerous as the summer advances in Egypt.

Mr. **de Fluiter**: From the difference between the amount of honeydew excreted by the coccids in the dry season and the amount of honeydew excreted by them

in the wet season Dr BETREM concluded to an unfavourable physiological condition of the plant (coffeetree) as a source of food in the wet season. I don't think this can be done. In the dry season the coccids have to take much more food from the plants to supply their water content than they have to do in the wet season.

Besides this we know that if ants are present and attending the mealybug colonies the population density can be very high, even in the wet season.

How did the speaker estimate the amount of honeydew excreted by the mealybugs?

Mr. **Betrem**: I don't think a so large difference in evaporation of the coccids does exist between the dry and the wet season. The coccids are living between the berries of a fruit bunch ("dompolan"), where the air motion will be very slight. The relative humidity there will be high even during the dry season. No data, however, are available. About the real action of the ants on the coccids we don't know very much. Furthermore during the wet season the density of the population remains always much lower than during the dry season; this involves, that during the dry season other factors are working than during the wet season, even if ants are present.

Mr. **van der Vecht**: Is the greater susceptibility of eelworm infested coffee plants to *Xyleborus* ascribed only to a reduction of the water content of the tissues? Do not changes in the chemical composition of the tissues play an important part?

Mr. **Betrem**: Indeed, not only the water content is of importance to the *Xyleborus* attack. The chemical composition of attacked and not attacked branches without doubt is different. The severely attacked branches contain less starch than the not so severely attacked ones.

EPIDEMIOLOGY OF SOME TOBACCO PESTS IN DELI (SUMATRA)

by

P.A. VAN DER LAAN

Bogor, Indonesia

Apart from some of our fellow-men, perhaps the insects are our greatest enemies. They contest our progress in agriculture with the utmost vigour and our control measures are far from perfect.

Wherever the interests clash – some caterpillars love nothing in the world more than eating Deli tobacco and we love nothing better than smoking it – the war against insects continues unabated.

Entomological problems in tobacco culture on Sumatra are manifold. Three species of Noctuids, a mining Gelechiid, an Aphid, a Capsid, grasshoppers, crickets, ants etc. keep tobacco growers busy the whole time. As the estates grow tobacco for wrapper leaf only, each hole caused by insects diminishes the value of the product considerably.

Many entomological investigations were made throughout the years 1906-1942 and a large number of publications were issued by the Deli Experiment Station.

When in 1863 the first tobacco fields in Deli were planted, practically the whole country was still under jungle. The virgin jungle-soil produced an excellent crop, but replanting proved impossible because of exhaustion of the soil. Therefore the cultivation shifted to new clearings. After some years, however, the area planted with tobacco increased to such an extent that growers were forced to use the same land over again, although only after several years of lying fallow. In the course of the years a system of crop rotation has been developed wherein tobacco was planted on the same field once every eight years. So each tobacco crop was followed by seven years of fallow and seven eighths of every estate became covered with wild vegetation. Every year, however, the tobacco fields are invaded by phytophagous insects, migrating from this mixed vegetation.

Initially control was attempted by applying chemicals and next to hand-picking, chemical control is still the chief method of control today, the growers being very careful not to leave any residue. The quantity of insecticide used is strictly limited to the amount which the tobacco leaf can take without harm to its quality.

An investigation on the life history of the tobacco insects, inhabiting fallow lands (1), showed that they live on certain weed vegetations when tobacco is not available. Eradication of these vegetations, mainly consisting of shortlived plants, before tobacco is planted, seems to be both practical and economical.

Moreover the frequency of certain species of plants in the fallow lands may

be very important. Thus the occurrence of the imported perennial shrub *Eupatorium odoratum* L., which spread within a few years over several estates, could be correlated with the frequent occurrence of a formerly innocent virus disease in tobacco (so-called "pseudomosaic"). The shrub appeared to be the main host of the virus. The Aleurodid *Bemisia tabaci* Genn. frequently breeds on Eupatorium and transmits the disease to tobacco (2). In 1940 and 1941 some estates had to be temporarily closed because of the heavy losses caused by pseudomosaic.

The Aphid *Myzus persicae* Sulz, well-known as a vector of numerous virus diseases, does not act as such for the Deli tobacco, but causes direct damage to the leaves. Only wingless females are found, but in dense colonies also winged ones. The Aphids are harmful only on the hill-estates (up to 250 m). In the plains no damage by Aphids occurs.

The behaviour of the fire ant (*Solenopsis geminata* F.) in Deli which can be troublesome as a seedrobber, is also remarkable. Until a few years ago it was only a minor pest but recently the ants have become a serious nuisance in seedbeds which were sterilised against slime disease by steaming. One year after steaming the ants appeared in unusually large numbers and they had to be controlled by mixing the seed with DDT or derris.

There is one pest which breeds on tobacco only. It is the stem borer (*Phthorimaea heliopa* Low), causing gall-like swellings of the stems of young plants. Removing all debris of tobacco plants, after the crop is harvested, is advised as the best control measure. No other foodplant except tobacco has ever been found.

A factor, long neglected in the investigations, which in tropical regions has also a great influence on the occurrence of insect pests, appears to be the rainfall. Due to the fact that abundant rains are indispensable for a good tobacco crop, exact data have been compiled on the monthly rainfall on the East Coast of Sumatra over a long period of years. The frequency and severity of several insect pests are also known over a period of about 15 years.

It appeared to be a promising idea to compare these rainfall data with insect damages, especially those caused by the Noctuid moths *Prodenia litura* L., *Plusia signata* F. and *Heliothis assulta* Guen.

Tobacco in Deli is sown in the (relatively) driest month February. The two previous months, December and January, are very wet as a rule. During these months the caterpillars feed on the shortlived weeds (viz. figure 1). In the dry months February and March the available food decreases and thereby the population of caterpillars. Transplantation of tobacco seedlings to the fields begins in the middle of March. The tobacco plants grow up from April till mid-July, taking advantage of the so-called "small rainy season" from April to June. Caterpillars profit also, primarily from the rain and the more luxuriant weeds, secondarily from feeding on tobacco leaves.

In order to investigate a possible correlation between rainfall and insect damage over a range of years (1925-1940) we have made a graph of the

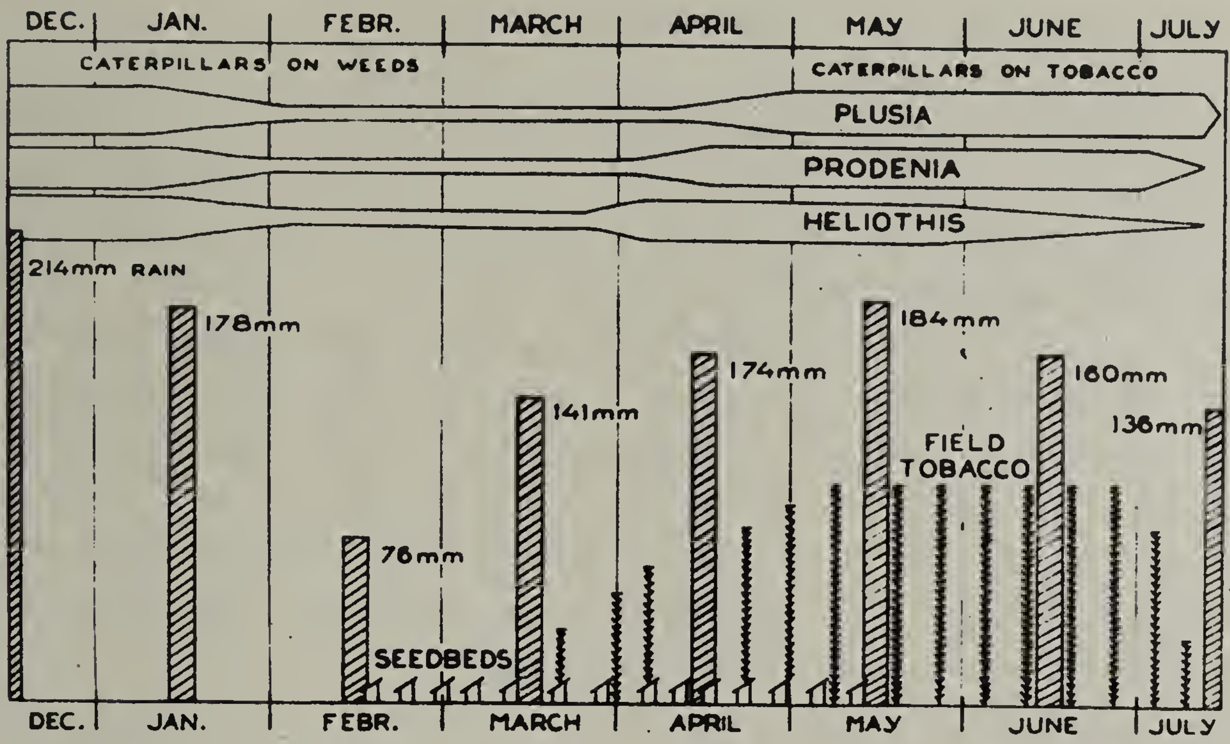

DEC.
JAN.
FEBR.
MARCH
APRIL
MAY
JUNE
JULY
CATERPILLARS ON WEEDS
CATERPILLARS ON TOBACCO
PLUSIA
PRODENIA
HELIOTHIS
214mm RAIN
178mm
76mm
141mm
174mm
184mm
160mm
136mm
FIELD TOBACCO
SEEDBEDS

Fig. 1.

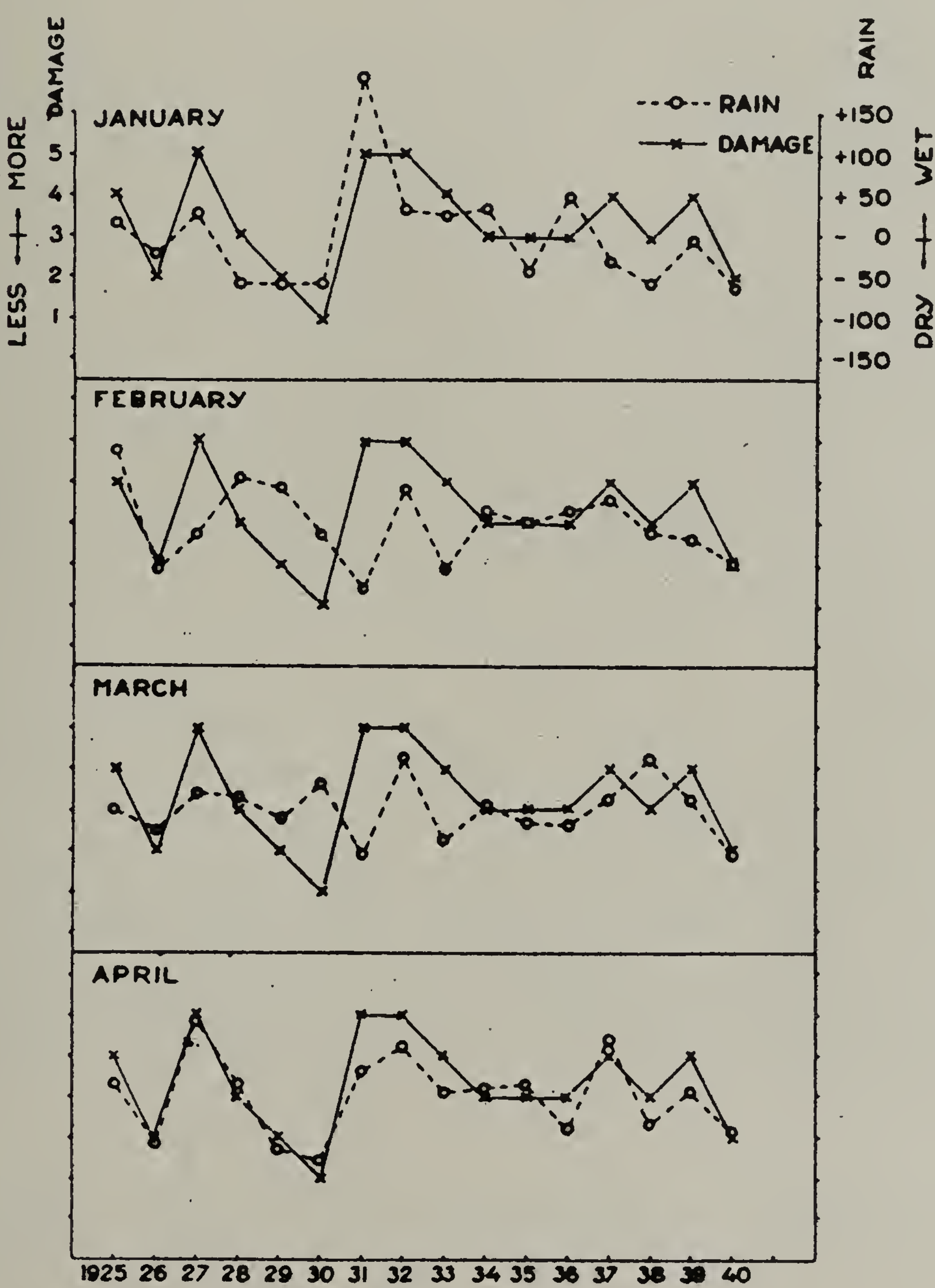

DAMAGE
LESS — MORE
RAIN
DRY — WET
JANUARY
FEBRUARY
MARCH
APRIL
RAIN
DAMAGE
+150
+100
+ 50
0
- 50
-100
-150
1925 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

Fig. 2.

rainfall data of ten stations spread over the tobacco area for the months January, February, March and April separately. The average rainfall for each year was compared with the average total rainfall, also calculated for 1925-1940 only. In this way we obtained deviations from the annual rainfall for each of these four months during this period. The data forming the broken line in figure 2 show for example that January, 1931 was very wet, February and March, 1931 very dry, April, 1931 wet.

Figures on the actual damage caused by the caterpillars were derived from the annual statistics published by the Deli Experiment Station, using 5 degrees of severity from 5 (catastrophic damage) to 1 (damage almost absent). As, in the statistics, the damages are figured for the whole planting season, these figures had to be inserted for each year (the year in question) and the resulting graph (the continuous line in figure 2) had to be repeated for each of the 4 months taken into consideration.

Closest correlation between the lines is shown in the month of April. Abundant rain just after transplanting causes rapid growth of the tobacco plants which produce many broad and juicy leaves, very suitable as food to the caterpillars. Rapid reproduction by several generations of the lepidopterous pests leads to considerable damage to the tobacco crop. Dry weather in April gives no damage.

Some correlation is also shown for the month of January. Heavy rains in this period, before tobacco has been planted, cause luxuriant growth of weeds and a rapid multiplication of caterpillars who afterwards infest the tobacco plantations. For example in the year 1931 the heavy damage was mainly caused by the rains in January, not by those in April.

Scarcely any correspondence between rainfall and insect damage is evident in the February and March data. In March tobacco is still on the seedbeds where practically all insects are destroyed by chemical control. The effect of rain on the weed vegetation is less pronounced than in January.

The pronounced correlation between rainfall and insect damage in April is most unfortunate for the tobacco growers. For the higher the rainfall, the better is the quality of the product and thus the best crops are also the most heavily infested.

Furthermore it is clear that the greatest intensity of insect attack is affected by the tobacco culture itself; the plantations are the main source of the high rate of multiplication of the insects.

A weather forecast by a meteorological station has not yet been established on Sumatra's East Coast. If such forecasts could be made, the newly gained knowledge about the correlation of rainfall and caterpillar damage should facilitate an effective intensification of control measures against the caterpillar pests of Deli.

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DISCUSSION

Mr. **Jepson**: Is the presence of alternate hostplants important in the epidemiology of *Heliothis?*

Mr. **van der Laan**: As *H. assulta* has only one important other food plant, namely the Solanaceous plant *Physalis angulata*, it is really important to eradicate this weed before tobacco is planted.

LOCAL DIFFERENCES IN FOODPLANTS OF PHAEDONIA INCLUSA (STåL), "THE SOYBEAN BEETLE" (COL., CHRYSOMELIDAE)

by

G.W. ANKERSMIT *)

Bogor, Indonesia

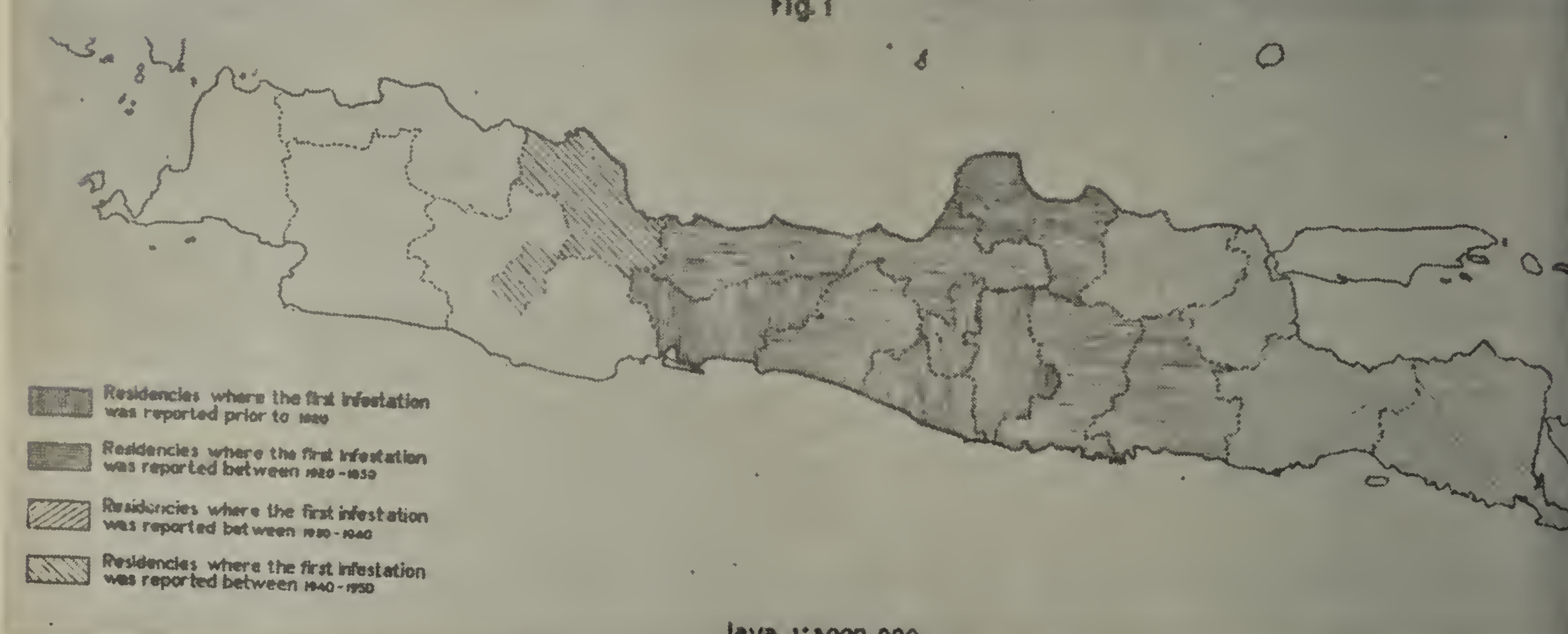
Introduction

Phaedonia inclusa is perhaps the most serious pest of soybean in East- and Central-Java today. In West-Java however, as well as in Sumatra (with the exception of one locality in the southern part) and in Malaya – regions included in the natural habitat of the species – the pest so far has never been observed on soybeans. Near Bogor in W. Java, where soybean is extensively cultivated in the Experimental Gardens, Phaedonia can only be found on Desmodium spp. and on Pueraria phaseoloides, both leguminous plants used for green manuring. In the course of the investigations, carried out during recent years in order to find control measures for the beetle as a soybean pest, an explanation for this remarkable fact was arrived to.

History of the pest

The beetle – described in 1858 from Java as "*Plagiodera inclusa* Stål" – was first mentioned as a pest of soybeans in 1905 near Banjumas in Central-Java. Fig. 1 shows how the pest spread during the following years over the

Fig. 1



central and eastern part of the island. Especially in the years 1920-'40 the infested area rapidly increased. This probably was mainly due to the increase of the area planted with soybeans in those years, offering greater opportunity

*) Communicated by Dr P.A. van der Laan.

for the beetle to be transported and to settle in new localities (fig. 2, 3). At the present the pest occurs all over Central- and East-Java.

In 1940 it was reported from South Sumatra in soybean fields of Javanese colonists. So far no reports have been received about the occurrence of the pest on the isle of Bali (located east of Java) where soybean is cultivated to some extent.

Observations and experiments on foodplants of Phaedonia

Looking for an explanation why Phaedonia does not attack soybean at Bogor – such an infestation, if it had ever occurred, would have been reported immediately, as the experimental plots are under constant observation – it was first thought that the beetles of Desmodium might belong to a distinct species. Morphological differences, however, could not be detected between the Phaedonia from Desmodium of West-Java and the Phaedonia from East-Java. Moreover the beetles interbred freely. The suggestion was therefore put aside. Another possibility appeared to be the presence of two "strains" or "adaptations". So experiments were started with the purpose of ascertaining to what extent the "Desmodium-Phaedonia" could be fed artificially on soybean leaves, and the soybean beetles on leaves of Desmodium.

Beetles from Desmodium, kept in cages, were given bunches of equal size of leaves of soybean, Desmodium ovalifolium and Pueraria. During a few weeks the number of holes made in the various leaves were counted. The same experiment was then carried out with beetles originating from the soybean fields of East-Java. In both cases the beetles showed a distinct preference for the leaves of their actual foodplants.

In a further experiment larvae of "Desmodium-Phaedonia" were given soybean leaves exclusively. Though many succumbed, a sufficient number survived and developed into beetles. Fifteen of these beetles were used in a new experiment with the same arrangement for choice of food. These 2nd generation beetles proved to prefer soybean leaves on the first day only but not on subsequent days, so the ultimate results were as follows:

date	number of holes made in leaves of:		
	soybean	Pueraria	Desmodium
26/9-'50 - 12/10-'50	54	96	156

From these figures it is evident that the Phaedonia's from the Desmodium stock, though reared during their larval life on soybean leaves, still in the imaginal stage prefered the original foodplant, Desmodium.

Observations in the field proved that it is impossible to infest a soybean crop in Bogor with Desmodium beetles. On two occasions 800 beetles were introduced into a soybean field, but all the beetles left the field and disappeared within two days. Moreover a soybean field adjoining a heavily infested Desmodium field was not attacked. When this Desmodium was almost completely destroyed the beetles migrated to Pueraria in the neighbourhood

Fig. 2

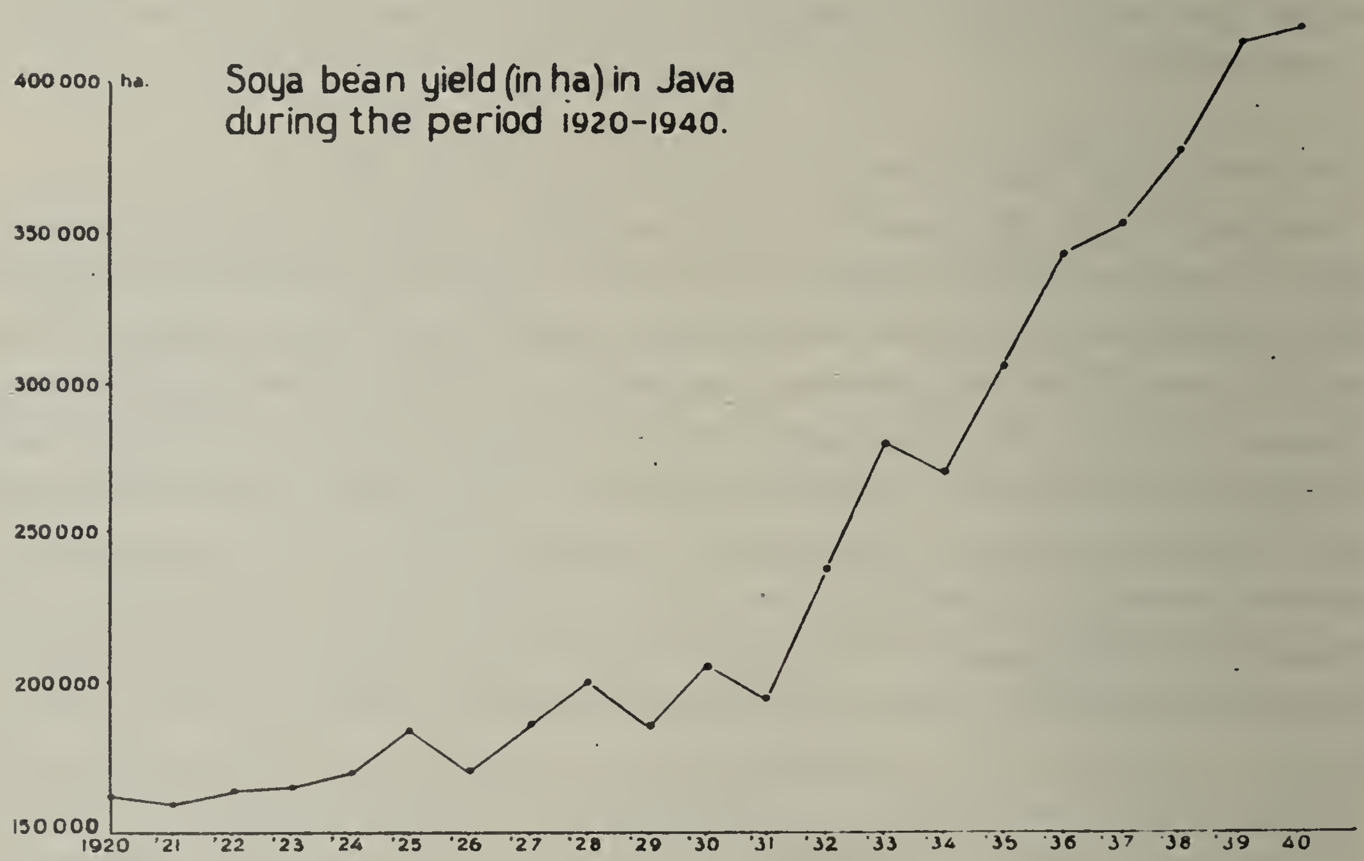
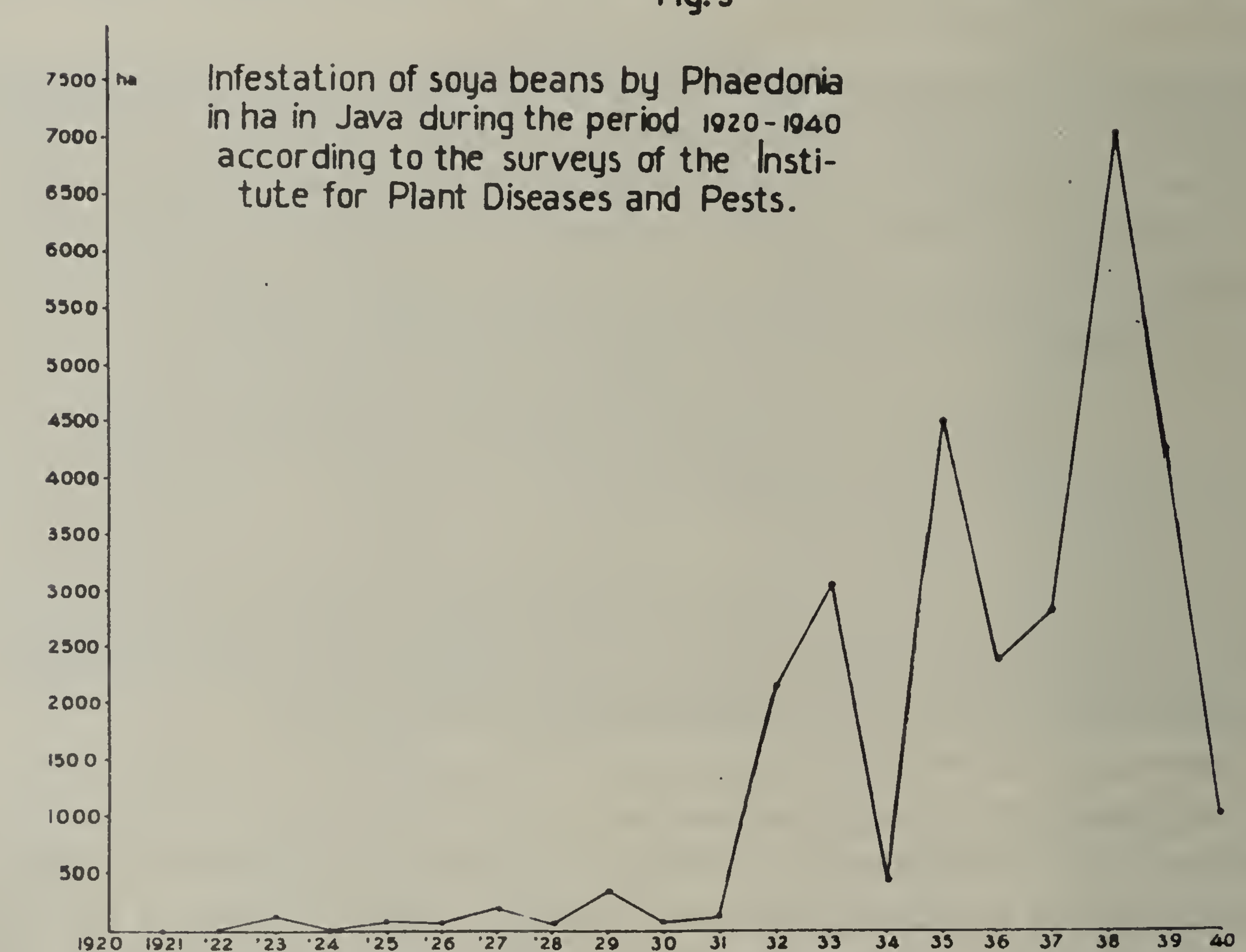

Soya bean yield (in ha) in Java
during the period 1920-1940.
400 000 ha.
350 000
300 000
250 000
200 000
150 000
1920 '21 '22 '23 '24 '25 '26 '27 '28 '29 '30 '31 '32 '33 '34 '35 '36 '37 '38 '39 40

Fig. 3


Infestation of soya beans by Phaedonia
in ha in Java during the period 1920-1940
according to the surveys of the Insti-
tute for Plant Diseases and Pests.
7500 ha
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
1920 1921 '22 '23 '24 '25 '26 '27 '28 29 30 31 32 33 34 35 36 37 38 39 40

but they did not move directly nor indirectly (via the Pueraria) to the adjacent soybean plot.

In 1930 a Pueraria field near Djember in East-Java was attacked by Phaedonia. At that time the pest was not known to occur on soybeans in that region. In 1949 the author found a Pueraria plant infested with Phaedonia at Genteng in East-Java (45 km south-east from Djember). Soon afterwards a nearby soybean field was attacked, the infestation originating from the Pueraria. Again in 1950 a Pueraria plot was infested by Phaedonia in the experimental garden Muara near Bogor; however, in the surrounding soybean fields no beetles could be detected. So in East-Java Phaedonia can migrate from Pueraria to soybeans, while in West-Java it does not.

In 1950 the author came upon a large number of the beetles in a grassy field near Pati, a locality in Central-Java where Phaedonia is a very serious pest for soybeans. In this field a considerable number of Desmodium triflorum plants were found, which species is known in Bogor to be accepted as a food-plant by the local Phaedonia. However, no eggs were found and only very few larvae could be detected on the leaves. Strangely enough large quantities of eggs were found on another wild leguminous plant, viz. Flemingia lineata, growing in the same field, but again no larvae could be found on them and experiments showed that the Phaedonia larvae from soybean stock do not accept the Flemingia leaves for food. So it was demonstrated under natural conditions that the Phaedonia beetles, who had undoubtly developed in soybean crops, were not able to raise their offspring on the common indigenous leguminous plants, although the beetles were attracted to one of them for oviposition.

Conclusion

The consideration of all facts combined has lead to the following conclusion: From the original population of *Phaedonia inclusa*, associated with indigenous plants like Desmodium spp. and Pueraria, a strain developed which was adapted to soybean, a crop not indigenous in Java, but introduced some 3 - 400 years ago. This adaptation apparently occurred shortly before 1905 in the southern part of Central-Java. Beetles of this strain were still in some degree attracted to other leguminous plants for feeding and oviposition. The new strain spread easily to East-Java owing to the abundance of soybeans in that part, probably reaching the East coast between 1940 and 1950, but it did not spread to West-Java where no soybean crop is raised by the native population. About 1940 the strain inadvertently was taken to South-Sumatra by Javanese colonists, most probably with cattle fodder.

The original *Phaedonia*, feeding on leguminous weeds, is still present in West-Java, Malaya and probably in large parts of Sumatra. It is not known whether it still exists in Central- and East-Java.

DISCUSSION

Mr. **Theodorides**: Are any parasites of *Phaedonia inclusa* known?

Mr. **van der Laan**: No egg-, larval- or pupal-parasites have been found, though they were looked for particularly.

ON THE FAUNA OF INSECTS INJURIOUS TO THE RICE PLANT IN JAPAN

by

Saturo KUWAYAMA

Sapporo, Japan

Rice is a high calorie-producing food crop, being most suited as staple food for the taste of Japanese people just as it is for other Far Eastern countries. So, in Japan, since rice-culture was first begun no less than twenty centuries ago, it has developed remarkably year by year. We can now find rice-fields all over the country from Hokkaido excepting her north-eastern parts in the north to Kyushu in the south. This is a range from about 30.2° N to 45.0° N latitude and from 128.5° E to 144.8° E longitude. The irrigated rice land, or paddy field, in percentage of cultivated land as of 1948 attains as high as 55.2% on the average, and from 20.2% in Hokkaido to 90.5% in Toyama Prefecture.

As in all other agricultural countries, or as in other crops, the rice plant is not exempt from the attack of various insect-pests, some of which often play a role as the cause of a bad harvest or scarcity as a result of their serious injuries. For conspicuous examples, a severe calamity caused by certain rice-pests was recorded early in 701 from 17 provinces of west central and southern Japan. An even more terrible famine caused by the rice plant-hoppers occurred in 1732 almost all over Japan except Hokkaido. In 1897, the loss by an extraordinary outbreak of rice plant-hoppers was estimated at 1.1 million kiloliters of grain in 2.7 million hectares of paddy-fields all over Japan. Recently, in 1940 damage by the same pests resulted in the loss of 0.3 million kiloliters from 8 hundred thousand hectares. In fact, the insect-pests that affect rice plant are exceedingly numerous, and from sowing time in spring to harvest time in the fall the sequence of injuries by various rice-pests may be observed every year. Although accurate statistics are lacking, it is believed that insect damage probably reduces the production an average of at least 7 per cent annually even with the present control measures.

With regard to the number of species of rice insect-pests in Japan, since KAIBARA recognized 4 sp. as early as in 1709, and OKURA enumerated 10 sp. in 1826, many research workers have recorded many sp., especially in recent years. In 1906 MATSUMURA enumerated 71 sp., and in 1926 OKAJIMA 157 sp., in 1927 MURATA 161 sp., in 1936 HIRANO 230 sp., and in 1943 YAGO 283 sp. These do, however, include some indigenous species of Formosa, the Loo-choos, or Korea. For instance, one should subtract 32, resp. 67 of these indigenous species from OKAJIMA's and YAGO's enumerations. On the local fauna, the author enumerated 21 species of the rice insect-pests in Hokkaido in 1926 and recognized 48 species of the same in 1942. OKAJI-

MA enumerated 60 species as the rice insect-pests from Kyushu in 1934. The author's painstaking census for Japan proper is now as follows:

Table 1. Conspectus of the rice insect-pests in Japan

Order	Family	Species	Percentage
Collembola	1	1	0.5
Orthoptera	5	35	17.2
Thysanoptera	2	3	1.5
Hemiptera	20	86	42.3
Trichoptera	2	5	2.5
Lepidoptera	6	32	15.8
Coleoptera	9	25	12.3
Hymenoptera	1	2	1.0
Diptera	7	14	6.9
Total	53	203	100.0

As shown here Hemiptera are most numerous, accounting for 42 per cent, followed by Orthoptera, Lepidoptera, Coleoptera, Diptera and Trichoptera. The species of Thysanoptera, Hymenoptera and Collembola are very few. It is noteworthy that 19 aquatic species of 5 orders are included, due to the fact that 97.3 per cent of the rice-fields in Japan are cultivated by irrigation method. On the other hand, we can enumerate 25 species of 6 orders as the insect-pests confined to non-irrigated rice lands or upland rice-fields. They are tabulated as follows:

Table 2. Comparison of the insect-pests confined to paddy rice and upland rice

Order	Paddy rice pests	Upland rice pests
Orthoptera	-	Gryllidae (6 spp.)
Hemiptera	Belostomatidae (1 sp.)	Aphididae (1 *Anoecia*-sp.) Eriosomatidae (1 *Tetraneura*-sp.) Pseudococcidae (1 *Geococcus*-sp.)
Trichoptera	Leptoceridae (2 spp.) Limnophilidae (3 spp.)	-
Lepidoptera	Pyralidae (4 *Nymphula*-spp.)	Noctuidae (1 *Gortyna*-sp.)
Coleoptera	Dytiscidae (3 spp.) Hydrophilidae (1 sp.) Chrysomelidae (2 *Donacia*-spp.)	Carabidae (1 *Scarites*-sp.) Elateridae (1 *Melanotus*-sp.) Chrysomelidae (1 *Chaetocnema*-sp.) Curculionidae (2 *Scepticus*-spp.) Scarabaeidae (Larvae of 7 spp. of different genera)
Hymenoptera	-	Formicidae (2 spp.)
Diptera	Stratiomyiidae (2 spp.) Chironomyidae (1 sp.)	Anthomyiidae (1 *Hylemyia*-sp.)

The species of insects which infest the rice plant in warmer districts are more numerous than in colder districts, there being represented 93 species in Hokkaido, 193 species in Honshu, 124 species in Shikoku, and 158 species in Kyushu. In other words, the species originating in the palaearctic region are less numerous than those found in the oriental region. Also, it may be said that the rice-pests belonging to Orthoptera and Hemiptera are predominant in the south temperate or subtropical zone while those of Diptera and Coleoptera are rather numerous in the north temperate zone. OKAJIMA explained that this fact may arise because the rice plant, being of a tropical origin, is certainly accompanied by the insects infesting it from the tropics to any locality to which it is introduced. However, it is observable in some cases that the rice plant becomes host to endemic species in a given locality. The species number of rice-pests in the four main islands of Japan is closely correlated with total area and total cultivated land, coefficient of simple correlation between ratio to total species and irrigated rice land as percentage of total area being calculated 0.94 ± 0.058 and those of total cultivated land 0.87 ± 0.122. From these facts it may be considered that the areal fluctuation of the host plants is added as one of the influential environmental factors in regard to insect-pests in certain localities. To visualize the above mentioned facts the author prepared the following tables.

Table 3. Distribution of the rice insect-pests in Japan

District	Coll.	Orth.	Thys.	Hem.	Trich.	Lep.	Col.	Hym.	Dipt.	Total	a	b	c
											%	%	%
Hokkaido	0	10	2	30	4	16	20	2	9	93	45.8	2.4	20.7
Honshu	1	32	3	82	5	30	25	2	13	193	95.1	10.2	61.2
Shikoku	0	25	1	51	2	20	18	2	5	124	61.1	7.6	56.1
Kyushu	0	29	1	71	2	23	22	2	8	158	77.8	10.7	54.2
Total	1	35	3	86	5	32	25	2	14	203	-	8.4	53.7

(a: ratio to total species; b: irrigated rice land as percentage of total area; c: irrigated rice land as percentage of cultivated land.)

Table 4. Groups according to Palaearctic or Oriental inclination

Species distributed	Coll.	Orth.	Thys.	Hem.	Trich.	Lep.	Col.	Hym.	Dipt.	Total
Japan and Siberia or Europe	0	2	1	14	4	7	6	0	3	37
Japan endemic, also Korea or China	1	2	0	25	1	5	8	2	10	54
Japan and Formosa or India	0	27	1	35	0	13	8	0	1	85
Japan, Formosa, India, Siberia or Europe	0	4	1	12	0	7	3	0	0	27
Total	1	35	3	86	5	32	25	2	14	203

The rice plant is always an object of attack by the insect-pests; no parts

of the plant can escape from their injuries. Among them leaf insect-pests are most predominant, followed by stem and leaf-sheath insect-pests; on the ear there are not so many and on the root very few. The data obtained are given in Table 5.

Table 5. Rice insect-pests classified by the injured part of plant

Part of plant	Coll.	Orth.	Thys.	Hem.	Trich.	Lep.	Col.	Hym.	Dipt.	Total	a	b
											%	%
root	0	1	0	4	5	1	12	0	5	28	13.8	8.1
stem & sheath	1	19	0	80	3	8	2	2	7	122	60.1	35.2
leaf (blade)	0	31	2	80	0	27	7	0	4	151	74.5	43.5
ear	0	14	2	19	0	1	2	0	1	39	19.2	11.2
Mechanical disturbance	0	0	0	1	0	0	4	0	2	7	3.4	2.0
Total	1	35	3	85	5	32	25	2	14	203	-	100.0

(a: ratio to total species; b; percentage of species in each plant part.)

Of these rice insect-pests suctorial type injuries are inflicted by 88 species of Hemiptera and Thysanoptera, and mandibulate type injuries by 108 species of Collembola, Orthoptera, Trichoptera, Lepidoptera, Coleoptera, Hymenoptera and Diptera, but 7 species belonging to Belostomatidae of Hemiptera, Dytiscidae and Hydrophilidae of Coleoptera, and Stratiomyiidae of Diptera disturb the rice-seedling by jumbling and pulling down the young plants.

Moreover, it is noticeable that some of the insect-pests are not only harmful by their feeding on rice plants but that also they act as the vector to transmit certain virus diseases. For examples, rice leaf-hoppers such as *Nephotettix bipunctatus cincticeps* and sometimes *Deltocephalus dorsalis* transmit the virus of rice dwarf or stunt disease and the rice plant-hopper, *Delphacodes striatella,* transmits the virus of rice stripe disease. The former fact was already observed by TAKATA as early as 1895 and precisely studied by FUKUSHI in 1934; the latter was proved by KURIBAYASHI in 1931. The rice yellow dwarf is also known as a virus disease transmissible through the agency of *N. bipunctatus cincticeps.*

Among the rice insect-pests hitherto recorded in Japan the following species may be ranked to be the most serious and decidedly important:

1. Rice locust (*Oxya velox* FABR. and allies)
2. Rice grasshopper (*Homorocoryphus jezoensis* MATS. et SHIR.)
3. Rice thrips (*Anaphothrips obscurus* MULL. and *Thrips oryzae* WILL.)
4. Rice bugs (*Scotinophara lurida* BURM. and *Lagynotomus assimulans* DIST.)
5. Rice leaf-hoppers (*Nephotettix bipunctatus cincticeps* UHL. and *Deltocephalus dorsalis* MOTS.)
6. Rice plant-hoppers (*Delphacodes striatella* FALL., *Sogota furcifera* HORV. and *Nilaparvata lugens* STAL)

7. Rice caddis-worms (*Setodes argentata* MATS. and *Oectis nigropunctata* ULM.
8. Rice stem borers (*Chilo simplex* BUTLER and *Schoenobius incertellus* WALK.)
9. Rice leaf-roller (*Cnaphalocrocis medinalis* GUEN.)
10. Rice leaf-caterpillar (*Naranga aenescens* MO.)
11. Army cut-worm (*Cirphis unipuncta* HAW.)
12. Rice leaf-wrapper (*Parnara guttata* BR. et GREY)
13. Rice leaf-beetle (*Lema oryzae* KUW.)
14. Rice curculio (*Echinocnemus squameus* BILLB.)
15. Rice crane-fly (*Tipula aino* ALEX.)
16. Rice leaf-miner (*Agromyza oryzae* MUN.)
17. Rice stem-maggot (*Chlorops oryzae* MATS.)

Several of the foregoing species have been examined in detail by many students, and besides spraying or other ordinary controlling measures some special measures are developed in Japan, such as light trap by blue fluorescent lamp against rice borers, spreading of kerosene or oils over irrigation water against hoppers and other insect-pests, etc. Prediction of the outbreak of major rice insect-pests is also safely established in recent years and is being put into practice at present.

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DISCUSSION

Mr. **Maher Ali**: Did you try to introduce parasites and predators? What is the status of the local parasites and predators?

Mr. **Kuwayama**: We in Japan introduced some egg- and larval parasites against the rice-stalk-borer (*Chilo simplex*) from southern parts of the Orient, but they did not establish. However, liberation or mass production of egg-parasites to some extent have given good results (*Trichogramma* against the stalk-borer, *Chilo simplex*, and *Anaphes* against the leaf beetle, *Lema oryzae*).

GROWTH HABIT OF CROP PLANT, AS AN ENVIRONMENTAL FACTOR OF INSECT PESTS

by

Hirohary YUASA

Nishigahara, Tokyo, Japan

It is a well-known fact that the growth habits of a crop plant vary with its stages, varieties, and culture methods and that these habits may naturally affect the environment of insect pests which attack the plant.

The environmental conditions induced by the habits of growth of the plant seem to control the population densities of insect pests, though it is necessary to analyze the real factor or factors of the environment which may affect the population densities of insects. However, it is very difficult to know how to express the growth habits of the plant quantitatively. The author and his associates have tried to calculate the so-called "growth habit indices" of the rice plant and to compare them with the population densities of certain kinds of rice insects. The following is a brief statement of the results obtained.

KATO and KOYAMA (1948) investigated the differences of first-brood egg numbers and first-brood larval mortality of the rice leaf miner, *Agromyza oryzae* Munakata, on 14 rice varieties and compared these differences with those of the growth habit indices of the same varieties. These indices of the rice plant were expressed as follows:

Growth habit indices = length of seedlings x age of seedlings x number of tillers.

According to the results obtained, as shown in Figs. 1 and 2, the population densities of the rice leaf miner seem to be correlated with the growth indices of the rice seedlings with the exception of a few varieties. In these exceptional cases the growth habit indices of the rice plant appear to be expressed unsatisfactorily, probably on account of the number of tillers or the length of the seedlings which might be overweighted in such exceptional varieties.

SUENAGA (1948) investigated the relationship between the growth habits of rice varieties and the population densities of the rice plant hoppers, *Sogata furcifera* Horvath and *Nilaparvata lugens* Stal. He expressed the growth habit indices of the rice plant as follows:

Growth habit indices = D h, where D = density of overspreading, and h = height of standing plants.

Again, $D = \frac{w \times n}{o} \times S$ where w = breadth of leaves, n = number of living leaves per hill, o = area to be covered per hill, and S = coefficient of overdevelopment.

Again, $S = \frac{(\frac{c}{2})^2 \times \pi}{o}$ (S to be used only in case of $S \geqq 1$), where c = diameter of hill crown (= the widest portion of hill).

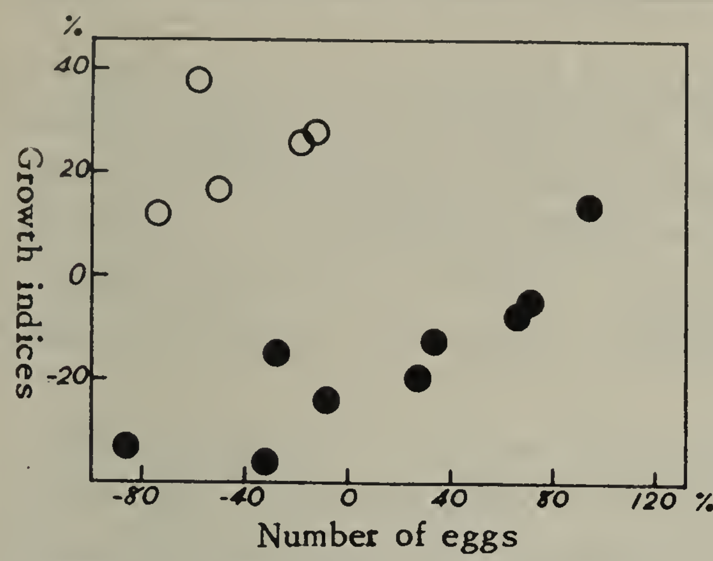

Fig. 1. Relationship of growth indices of rice seedlings to egg numbers of rice leaf miner (O: exceptional varieties).

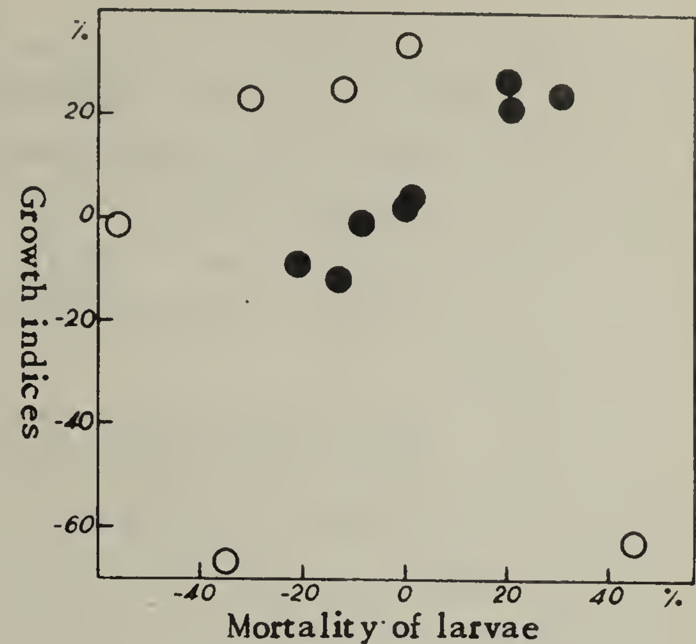

Fig. 2. Relationship of growth indices of rice seedlings to larval mortality of rice leaf miner (O: exceptional varieties).

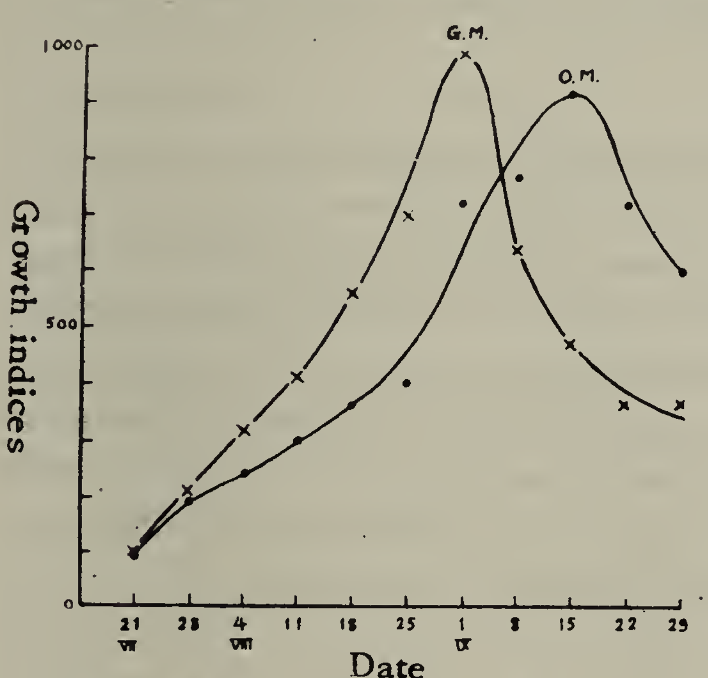

Fig. 3. Seasonal changes of growth indices on two rice varieties: Oita-Mii (O.M.) and Gaisen-Mochi (G.M.)

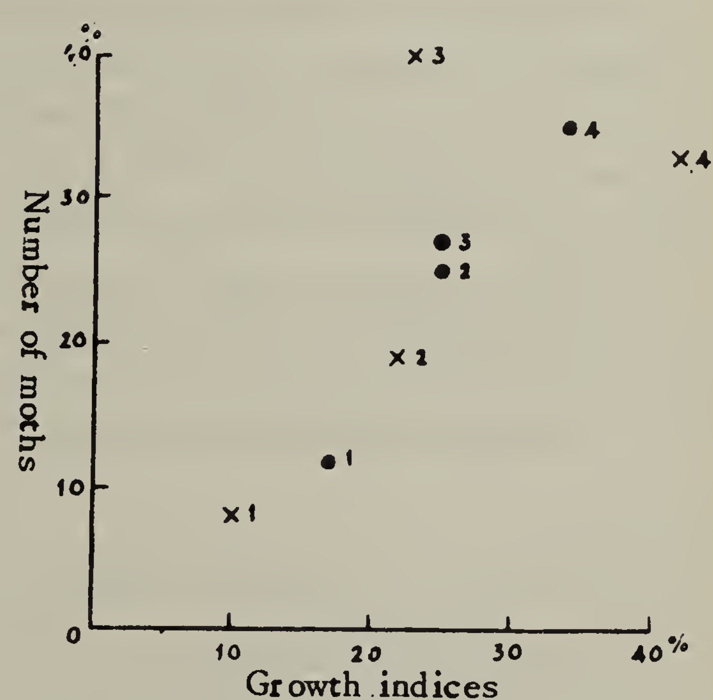

Fig. 4. Relationship of growth indices of rice seedlings to numbers of paddy borer moths (×: nurseries sown on April 20; •: nurseries sown on May 10; 1, 2, 3 and 4: ratio of quantities of seeds sown per unit area)

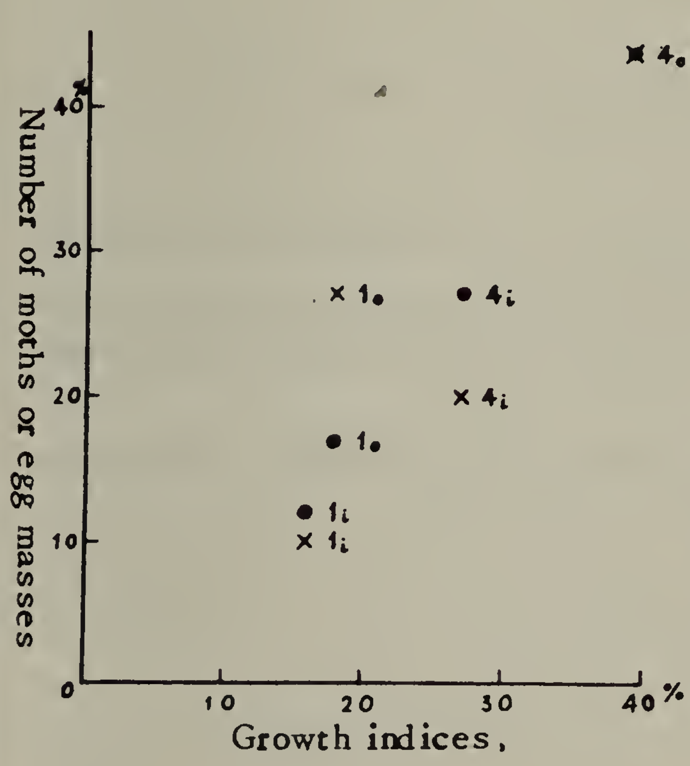

Fig. 5. Relationship of growth indices of rice seedlings to numbers of paddy borer moths or egg masses (×: number of egg masses; •: number of moths; 1 and 4: ratio of quantities of seeds sown per unit area; i: inner part of nursery; o: outer margin of nursery).

SUENAGA compared the seasonal changes of growth habit indices on two rice varieties: Oita Mii and Gaisen-Mochi. It will be clear from Fig. 3, that Gaisen-Mochi luxuriates faster than Oita-Mii, while the population density of rice plant hoppers is highest in summer in Gaisen-Mochi and in autumn in Oita-Mii. This indicates a close correlation between the growth features of the rice plant and the population densities of these two species of rice plant hoppers.

KOYAMA (1949) investigated the population numbers of the paddy borer moth, *Schoenobius incertellus* Walker, in several nurseries differing in sowing time and quantity of seeds sown per unit area. Comparing the population numbers with the growth habit indices from the different nurseries, he expressed the growth indices as follows:

Growth indices = length of seedlings x age of seedlings x breadth of leaves x quantity of seeds sown per unit area.

According to the results obtained, as shown in Fig. 4, the number of moths is closely correlated with the growth habit indices of the rice plant. KOYAMA also investigated the difference in growth habit indices of plants from the outer margin and the inner part of the same nurseries, and compared the differences with that of the numbers of moths or egg masses. The results are just the same as stated above (Fig. 5). KOYAMA measured furthermore the microclimatic conditions and came to the conclusion that the main factor controlling the population densities may be the microclimatic temperature in the night which varies with the growth habit of the rice plant.

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DISCUSSION

Mr. Box: Is there a possible similarity between rice conditions and those of sugar-cane fields, in which young unjointed sugar canes are more close to savannah, while the inside conditions in fields of jointed canes approach closer to tropical rain forest.

Mr. Yuasa: Yes, there is a similarity between rice conditions and those of sugar-cane fields.

NOTES AND RECORDS ON SOME IMPORTANT PESTS OF MICRONESIA MOSTLY INTRODUCED DURING THE PERIOD UNDER JAPANESE MANDATE

by

Teiso ESAKI

During my entomological explorations to the Micronesian islands in the years 1936-1940, I paid special attention to the injurious insects of various crops. Even in this short interval I personally observed the changing of the fauna of pests, affected by the cultural methods and the marine transportations. I accumulated also records of the outbreaks of pests, importations of new pests and introductions of natural enemies, most of which were never published before. The following notes are some of those records, relating to more important pests of crops.

The coconut plantations in the Micronesian islands were severely attacked by the coconut scale. *Aspidiotus destructor* Sign., in the years 1915-25. The scale outbroke in Yap before the World War I; it was introduced into Yap from the Philippines in 1892, when the island was a colony of Spain (COPELAND). The crop of copra diminished rapidly since that time, but the serious damages were observed much later, i.e. in 1905-06. GREEN believed that the scale which caused damages in Yap was *Aspidiotus oceanica* Lind. but not *A. destructor.* The former species, better known as *Furcaspis oceanica* Lind. at present, is also common in Yap, but this species becomes never a serious pest, and there is no doubt that GREEN's opinion was not correct. The coconut scale was later introduced into Palau from Yap. There are no authoritative records with regard to the actual date of the introduction of the scale into the Palau Islands, however, according to narratives of the natives, it was introduced by a chief of Peliliou in 1899, when he brought some betel peppers (Piper betle) from Yap, and the scales were attached on this plant. Another report says, that the scales were at first introduced into the small island, Garukoru, at the north cape of Babeldaob, the largest island of the Palaus, by a steamer of the West Caroline Company. The steamer used to bring betel peppers from Yap and presented them to the natives employed by the company and the scales were attached on them. The scale was most injurious in the Palau Islands in 1908, but it became less important later. Since the Marianne Islands were ceded to Germany, the plant quarantine was strictly enforced in Saipan during the years 1899-1907 by the German Governor, Georg Fritz, and the scale was not found there until 1911, when some native soldiers and workers were immigrated from Yap to Saipan. They brought than baskets woven with green

*) Author not present at Congress. Published by courtesy of the Editorial Committee.

coconut leaves and the scales were brought here attached on those baskets. The scale was noticed at Garapan, the chief village on the island, in 1912. The most destructive damages were observed in 1915-1916 (OHASHI). The natives called the pest as „gaga yap" or Yap insects. The coconut plantation in Rota was fatally attacked by the scale in about 1920. About at the same time it was also introduced into Guam, and caused serious damages on coconuts in the years 1924-1925. The records on this island are given in the Report of the Guam Agricultural Experiment Station, 1924-1926. According to Gregorio SABLAN, a highly educated native in Saipan, the scale was at first discovered in Guam in the plantation of the Atkins-Kroll Company at Tarague near the northern extremity of the island in 1920. A captain, called Malcom, of the company used to smuggle whisky from Saipan to Guam since 1918 and SABLAN believed that the scales were brought into that place by the natives who accompanied Malcom. In Saipan, as well as in Guam, the coconut scale was well controlled by the minute endemic Coccinellid beetle, *Telsimia nitida* Chapin, formerly recorded by VANDENBURG in Guam as *Cryptogonus orbiculus* var. *nigripennis* Weise.

Much later, the scale became gradually injurious to coconut in Ponape also, and it was realized an important menace in 1938-1939. It attacked coconuts severely at the northern coast of Ponape, especially in Jokaji, a small island at the western side of the Ponape Harbor. I introduced about 200 Coccinellids mentioned above, both larvae and adults, from Saipan to Ponape on July 13, 1939. This material was multiplied at the Experiment Station in Ponape and liberated some time later, but the further fate of the beetles was not ascertained. The coconut scale in Ponape was apparently introduced from a different route from that of Yap and Saipan. When Germans colonized this island many plants were introduced from various tropical countries, and there were much possibilities that the scale were attached on those plants.

The red coconut scale, *Furcaspis oceanica* Lind., is an endemic species in Micronesia and is widely distributed in the Marshall and Caroline Islands, including the Palaus. Sometimes it infests severely leaf-stalks and, to a less extent, leaf-blades and fruits of the coconut palm, but becomes never destructive. It feeds also on such wildpalms as Bentinckiopsis ponapensis and Ponapea Ledermanniana in Ponape, and B. carolinensis in Truk, as well as Nypa fruticans and Pandanus spp. According to my observation (ESAKI, 1939) the original host plant is B. ponapensis, which is an endemic palm in Ponape and is very abundant in the mountainous region of the island. This scale was never found in the Marianne Islands until 1943, when it was discovered in Saipan for the first time by FUJISHIMA, the government entomologist.

The coconut beetles are the most serious pests of coconut in Micronesia during the last years. There are three species of the coconut beetles of the Genus *Planispa* (Hispinae). They are all endemic to Micronesia, so far as

the present knowledge reveals, but there are possibilities that they were invaded from some other tropical countries, as they never feed on palms other than the coconut, and our extensive survey in many islands failed to find any parasitic insect upon them.

Planispa mariana Spaeth (= *P. castaneipennis* Chujo) is a chestnut-brown beetle and is distributed in Saipan, Rota, Yap, Truk and nearly all the atolls lying between Yap and Truk. This is the most destructive of the three species. *P. chalybeipennis* Zacher is dark greenish blue and was described from Ponape. It is widely distributed in Ponape and eastwards, as far as the entire atolls of the Marshall Islands. It is much less important than *P. mariana*. The third species, *P. palauensis* Esaki-et-Chujo is restricted in the Palau Islands. It appears more or less similar to the preceding species, but the coloration is less greenish and bright blue and there are distinct differences in the structure of the head and elytra. This is the least injurious of all the three species.

The brown coconut beetle became a serious pest in Saipan and by the end of 1939 nearly all the plantations on the island were destroyed. According to the records of the Administration in Saipan, the pest was recognized for the first time at Garapan in October, 1931. The pest increased rapidly in the next year, the infested area expanded from Garapan as far as Porto Rico and Tanapaco in the north, and Chalan Kanoa in the south. I observed that they were found nearly all over the island except some parts on the east coast and the Donni district at higher elevation in 1936, and three years later, in 1939, uninfested coconut palms were seen only at Inai Hagman, eastern point of the island and at Laulau on the south-eastern coast. Thus more than 90% of the palms were destroyed by the end of 1939. Although the original habitat of this pest was not to be ascertained within Micronesia, it is fairly certain that it was spread from Yap over small atolls as far east as Truk. The importation into Saipan was quite recent as mentioned above, and it is assumed to have been brought from Yap directly. The damage is especially severe during the dry season. which is much more pronounced in Saipan than in other Micronesian islands and this is the reason of the outbreak in that island.

The rhinoceros beetle, *Oryctes rhinoceros* L., is reported to be a serious menace of the coconut plantations in the Palau Islands recently, however this species is a new-comer during or after the World War II. In spite of our careful survey in successing years, the beetle was never found in Palau or any other island of Micronesia until 1941.

The melon fly, *Chaetodacus cucurbitae* Coq., was at first recorded from Guam by SWEZEY in 1940. This fruit fly was undoubtedly introduced from the Philippines some time prior to that time, as suggested by this author. It was not found in Guam until 1932, when the Agricultural Experiment Station was closed and the entomologist VANDENBURG, left the island. In other islands of the Mariannes, or elsewhere in Micronesia, the melon fly did not exist until as late as 1942, as especial attention was paid constantly

on this important pest there. At the beginning of the Pacific War the Japanese Navy occupied Guam on December 12, 1941, and since then transportations between Guam and Saipan by small vessels became very frequent. Therefore the Naval Administration Government issued the quarantine regulations prohibiting the export of cucurbits from Guam on February 26, 1942. In spite of this act, the fruit fly invaded into Saipan; the first adult fly was captured at an orchard in Tanapaco, Saipan on July 17, 1943, by Fujishima, the government entomologist, and 15 adults at Chalan Kanoa on July 25, 1943; then further survey was immediately undertaken on the neighbouring islands and the fly was discovered on July 29, 1943 on Tinian and on August 5, 1943 on Rota. Maggots of the melon fly in melon shipped from Saipan were intercepted at Yokohama by the Plant Quarantine in August, 1943. The Saipan Administration Government issued an order to prohibit the export of cucurbits and many other tropical fruits as well as plants attached with soil from Saipan, Tinian and Rota to other islands in Micronesia, on August 25, 1943.

The Oriental fruit fly (*Chaetodacus dorsalis* Hend.) was not found in Saipan in 1928, when KARIYA, Plant Quarantine Officer of Yokohama, visited there in order to search fruit flies of economic importance. Apparently the earliest record of this fruit fly from Saipan was made by the Saipan Branch Station of the Industrial Experiment Station of the South Sea Administration in 1935, in which the bionomics of the fruit fly in Saipan was described. The fly was then fairly abundant and attacked chiefly mango. It must have been introduced into Saipan a few years earlier than 1935, and undoubtedly from Okinawa, Ryukyu Islands, by the immigrants from there. I found it very abundantly in Saipan in 1936. It was introduced into Hawaii from Saipan in 1946 (FULLAWAY).

The other fruit fly which was most abundant on mango and other fruits in most of the principal islands in Micronesia was *Chaetodacus frauenfeldi* Schiner.

The banana weevil or root borer, *Cosmopolites sordidus* Germar, was not found in Saipan or elsewhere in Micronesia except Guam until 1939. I cut the stems and roots of the banana plant in many occasions in Micronesian islands, including Saipan, Yap, Palau, Truk and Ponape, but I never found the trace of this beetle. During my last visit to Saipan in 1939, I noticed a single specimen of this species, captured at Garapan, Saipan, on July 17, 1939 by AOKI, Plant Quarantine Officer, in the collection of the Plant Quarantine Service and I gave suggestions to the officials of Saipan that observations should be made and precautions should be taken. Next year, YASUMATSU and YOSHIMURA of our laboratory made observations there and they found it abundantly. It has been established in Formosa between 1909 and 1911 imported from Singapore (SHIRAKI and SONAN), and was recorded from the Bonin Islands and Okinawa in 1939 (YUASA). However the beetle had existed in the Bonins already as early as in 1914, as could be ascertained from a mimeographical bulletin on the banana cultivation of the islands

anonymously published by the administration of the islands in 1914, although it was not recorded by name. The weevil may have been introduced into Saipan either from the Bonins or from Okinawa.

Anomala sulcatula Burm. was at first recorded by SWEZEY from Guam in 1940. It was introduced undoubtedly from the Philippines much earlier than that date. I could not find it either in Saipan or Tinian in 1936, but there were two specimens in the collection of the Tropical Industries Experiment Station in Saipan, captured there in 1935 and 1936. Since the sugar planters in Saipan, Tinian and Rota adopted an extensive application of farmyard manure in the field, the beetle increased rapidly in number and became a serious pest in Rota in 1937 and in Saipan in 1939. The grubs attacked severely the newly planted shoots of the sugar cane. Larvae of a Tenebrionid *Gonocephalum* sp., known as the „wire worm" to the farmers, were often in association with them. The Nanyo Kohatsu Company undertook the introduction of a natural enemy from the Philippines in 1940 in order to control this new pest, and Dr. J.KONISHI was sent to Manila in search for Scoliid wasps. He introduced a Scolid in pupal stage from there and liberated it in Saipan in 1940. The first adult wasp was observed in September 1940. It became well established and was abundantly found in the following year, 1941. Although KONISHI identified the species he introduced as „*Scolia manilae* Ashmead", the specimens actually captured were *Campsomeris annulata* Fabricius. It is assumed that either the pupae from the Philippines were wrongly identified or the two species in question were mixed in the material and only one, C. *annulata* Fabricius, has been established.

The four-spotted leaf beetle, *Aulacophora quadrimaculata* Fabr., is very injurious on cucurbits in the Marianne Islands except Guam. In the Palau Islands the place of this beetle is replaced by *A. similis* Ol. and *A. marginalis* Chap. *A. quadrimaculata* is not found in Micronesian Islands except Saipan, Tinian and Rota, but it is widely distributed in the South Pacific. As the species is not found in Guam, I suspect that it was introduced into Saipan from Samoa during the German colonization, when Saipan and Samoa were regularly connected by steamers.

Finally I record the introduction of *Trichogramma chilonis* Ishii by the Nanyo Kohatsu Company in order to control the stem borer of sugar cane, *Eucosma schistaceana* Snellen, in 1935. The material was brought by Dr. KONISHI from the Shizuoka Agricultural Experiment Station in Japan, where it had been introduced from the Philippines as a possible natural enemy of the rice stem borer, *Chilo simplex* Butler. It was continuously multiplied and liberated into the cane field by the company.

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SECTION XI

STORED PRODUCTS ENTOMOLOGY

APPLICATION OF RESEARCH TO STORAGE OF FOOD

by

Stephen S. EASTER
Washington D.C., U.S.A.

The losses in stored food in spite of all efforts to reduce them still remain as a major problem in food and agriculture in the world. The Food and Agriculture Organisation of the United Nations has had the reduction of these losses as a major project for more than four years. A primary function has been to focus attention in many countries on the serious losses in stored foods through international meetings on the subject. Visits have been made to twenty or more countries to assist in grain storage system improvement. Some progress has been made indicated by improved methods of infestation control and the construction of grain storage facilities.

There is no intention to belittle the need for research but to point out that in nearly all the countries visited the immediate need is for application of research already well proven in a few countries. Examples are given of efforts to improve insect control methods which use newly developed fumigants and other insecticides while simple effective methods as sanitation and stock rotation are disregarded. Examples are also given of attempts to find easy methods of insect and rodent control under conditions difficult and uneconomic without proper facilities. In considering storage facilities the cost of the traditional bag is usually overlooked both as a storage unit cost per year and as a source of infestation. In general overemphasis has been placed on obtaining or demonstrating corrective methods of control rather than on the basis problem of good management in which insect and rodent methods become part of an overall good system where infestation control can be largely on a preventive basis.

Kodachrome slides are used to show types of grain storage facilities in various countries.

DISCUSSION

Mr. **D.W.Williams:** In view of cost of above ground storage for the undeveloped countries, has Mr. EASTER had much experience of the use of underground storage (in which the insects are killed by their own carbon dioxyd production) in such countries? What are the prospects of such storage?

Mr. Easter: Underground storage has been used a long time in Italy, but not in large bulk storage. At present Argentina, Uruguay and Paraguay are using a modification of this type of storage limited to certain areas due to soil conditions such as the water table. In these countries there is a considerable satisfaction in the results obtained with surplus grain. However, the higher

cost of conventional above ground storage should be balanced against the lower cost of handling.

Mr. **Parkin**: An important point in the application of insecticides is knowledge of the monetary and other losses which now occur during storage so that research-workers can form some idea of the economic possibilities of the methods of control they are investigating. It is hoped that the F.A.O. will try to gather such information from those countries in which it wishes to encourage better storage of foodstuffs.

DAMAGE AND LOSS TO STORED PRODUCTS FROM ATTACK BY INSECTS AND MITES

by

J.A.FREEMAN

Tolworth, Surrey, England

I. Introduction

Estimates have been made from time to time of the quantitative and financial losses due to attacks on stored products by insects and mites. These include the estimate in 1946 by an expert Committee of F.A.O. of 5% loss annually of all harvested cereals, pulses and oilseeds, a quantity equal to one half of these foods entering into world trade (5): 300 million dollars a year loss to all stored products in the U.S.A. in 1936 (13): three million tons of grain lost every year in India, including losses due to rodents and moulds (4): other examples are given by FREEMAN (7), FREEMAN and TURTLE (11) and ZACHER (25). Classifications and accounts of damage and loss caused by insects and mites have been made by GRAY (12) and MUNRO (15). In considering the question of loss and damage one must take into account the variation of standards in different parts of the world. In underdeveloped countries the peasant cultivator does not look too closely at the weevils in his food if he has nothing else to eat; in highly developed countries the presence of a few microscopic fragments of insects in food is regarded as sufficient grounds for condemnation.

II. Classification of Damage

(1) *Reduction in weight.* Any food attacked by insects loses dry weight because the insects burn up a high proportion of the food they eat. Direct losses of this kind amounted during the 1914-1918 war period in Australia to 2-5% in stored wheat (24). Such losses in dry weight may be hidden in practice by increase of moisture content of stored food due to absorption of water vapour from the air, as often occurs in the U.K.

(2) *Heating.* The mechanism by which insects can cause bulks of grain of a moisture content less than 15% to heat, has been demonstrated by OXLEY and HOWE (19) and by WILSON (23). Although this "dry grain" heating up to a maximum temperature of 42° C (108° F) does not normally affect the commercial qualities of food grains, it does damage the germinative power of seed and malting grain. The water movements associated with dry grain heating may cause damage through caking, attack by moulds and rotting due to bacterial attack and sprouting (16). If "dry grain" heating changes over to "damp grain" heating (with a maximum temperature of 62° C (144° F) serious damage to milling, baking and germinative qualities of grain will result (17).

(3) *Reduction of food value.* Insects feed selectively in grain. Thus the larvae of *Calandra granaria* L. tunnel in the endosperm of wheat, whilst *Tyroglyphus farinae* L. bores in the germ. The larvae of *Ephestia elutella* Hubn. destroyed 3,000 lbs germ in two years in a bulk of 500 tons Manitoba

wheat stored in a granary in London (20). Flour made from degermed wheat will have less vitamin B and iron than that made from sound wheat, since these food materials are concentrated in the germ and the tissues close to it.

(4) *Damage to the seeds of food plants.* If seed grain is attacked by germ eaters then it will not germinate. If the cotyledons or food reserves are eaten by insects the young seedlings may not be as strong as those from sound seeds. The damaged seeds may decay before germination due to attack through the ruptured testa by soil inhabiting pests, bacteria and fungi (6).

(5) *Tainting of food.* Food may be rendered unpalatable by the secretions of mites such as *Tyroglyphus farinae* and *Carpoglyphus lactis* L. or by those of beetles such as *Tribolium castaneum* Herbst and it may be impossible to remove the taint in course of manufacture or cooking. Maize meal made from infested maize is regarded as unpalatable by Africans (18).

(6) *Damage to the appearance of food.* Insects can so alter the appearance of food as to make it unacceptable to the consumer, even though the loss of weight is negligible and there is no tainting. This particularly applies to goods which reach the housewife in their original condition e.g. beans with holes or "windows" caused by Bruchids; nutmegs holed by *Araecerus fasciculatus* Deg. or to manufactured goods such as biscuits, packets of dried soup or meat cubes holed by *Stegobium paniceum* L. Holes made in the wrapper leaves or paper wrappers of cigars and cigarettes by *Lasioderma serricorne* L. not only disfigure but render them useless.

(7) *Contamination of food.* Living or dead insects or signs of their presence are objectionable in food, whether obvious or not to the purchaser. Such contamination may not only occur in the food in which the insects can breed, e.g. *Ephestia kuhniella* Zell. in flour, but also by cross infestation in commodities such as tea, e.g. infested by *Trogoderma granarium* Everts from groundnuts (9).

(8) *Interference with productive processes.* The web spinning activities of *Ephestia kuhniella* in flour mills may cause stoppage of production. Its larvae, and those of *Tenebroides mauritanicus* L. eat holes in bolting silk covers and the latter tunnel into woodwork (10). Bees and wasps are a nuisance in jam and canning factories and in the storage of sugar.

(9) *Damage to containers and the fabric of buildings.* Severe damage to bags has been caused by insects, particularly the larvae of *Ptinus tectus* Boiel., which have the habit of biting through the fabric of jute or cotton bags. With a heavy infestation the holing of the bags weakens them so much that when they are moved they split open. Damage to wooden boxes containing food and to the wooden fabric of buildings by food insects boring into them and by true woodboring insects may also occur on a scale sufficient to require measures of prevention and control (10).

(10) *Damage to amenities.* The mere presence of insects in dwelling houses, restaurants, hotels and hospitals may cause damage and inconvenience, quite apart from attack on food. Control measures have sometimes

to be carried out in private houses to deal with insects which have spread from food warehouses. – In restaurants and bakeries, cockroaches and ants (particularly *Monomorium pharaonis* L.) may find their way into cooked food, and crickets (*Gryllus domesticus* L.) migrate from rubbish tips to houses during the autumn.

(11) *Damage to human beings and animals.* The ingestion of food infested by mites is stated to cause digestive disturbances in man and domestic animals (21). The consumption of maize meal made from heavily insect infested maize causes diarrhoea in Africans (18). It is well established that contact with foodstuffs which have been at some time attacked by mites such as *Tyrophagus castellani* Hirst can cause dermatitis in workers handling them. The Division has found this trouble occurring in workers handling copra, cheese, maize and cartons soaked in damaged orange juice. – Conjunctivitis and other temporary skin irritations are caused by the fine hairs and cast larval skins of *Dermestes spp.* in cargoes of bones and *Trogoderma granarium* in cargoes of peas, groundnuts and grain. A kind of bronchitis found in workers in food stores in S.E. Asia was ascribed to the presence of mites living in their bronchii (22).

III. Classification of Losses

(1) *Loss in weight.* An actual loss in weight, when goods are sold on a weight basis, may lead to a corresponding financial loss.

(2) *Destruction of food.* Food which is too heavily infested and contaminated for salvage may have to be destroyed. Here the loss involves cost of replacement, removal of the infested goods and the cleaning and disinfestation of the place where it was stored.

(3) *Loss of commercial quality.* Goods may suffer loss in quality or value as the result of insect attack without being rendered unfit for their original use. For example, a cargo of Argentine maize, valued at £ 208.000 deteriorated by £ 10.000 as the result of damage caused by insect heating during a voyage to the U.K. in 1948.

(4) *Diversion of food.* Infested food is frequently diverted to uses other than those for which it was originally intended, e.g. human food to animal feeding. This results in a saving of material but usually some financial loss. – The saving of food by such diversion is more apparent than real, since a large proportion of the nutritive value of the food is used in keeping the animal alive and farm animals are normally used as convertors of food which is not suitable for direct human ingestion.

(5) *Interference with storage plans.* Raw materials and finished products are stored by manufacturers and traders and by Governments (food reserves) in the belief that they will remain in good condition and be available for use in due course. Insect attack which causes deterioration and which upsets the planned programme of use of such stocks can cause commercial losses to the trader and severe difficulties to Governments. Traders may be unable to replace infested stocks except at high prices; the destruction of famine reserves may result in the deaths of large numbers of people, or,

at best, in the import and distribution of foodstuffs at high cost and with dislocation of normal transport (13).

(6) *Interference with warehouse facilities.* Insects and mites breeding in one parcel of infested goods in a warehouse often spread to other goods and establish themselves in the building. Considerable trouble and expense has to be incurred by warehousekeepers in controlling such infestations in goods and in rendering the warehouses again fit for use.

(7) *Cross-infestation.* Losses may occur when insects move from one foodstuff to another (e.g. from wheat to flour (9) and from foodstuffs to non-food commodities. In 1950, adult *Calandra granaria*, *C. oryzae* L. and *Ptinus tectus* were found regularly in high class finished table and carpet felts stacked ready for despatch on the ground floor of a factory in the North of England. Investigation shewed that the insects had come from the first floor which had been used for a long time as an animal feedingstuffs store.

(8) *Interference with transport facilities.* Goods may be infested by being carried in infested transport (8, 9). During June, 1951 a large number of chests of tea had to be fumigated in Liverpool owing to infestation by *Tribolium castaneum* acquired from oilseeds in the hold of a ship. Examples of infestations originating from residual infestations in the holds of ships, barges and road transport are given by FREEMAN (8, 9). Expense may be incurred by shipowners in costs of treatment of holds before loading clean cargoes as in Canada (14), or after the discharge of infested cargoes, as not infrequently occurs in the U.K. Infested wagons on railways, and hired grain sacks, have to be hauled long distances empty to special centres where they can be adequately treated.

(9) *Interference with manufacturing processes.* Where insects are regular inhabitants of machines e.g. in flour mills, the expense of their control by cleaning and fumigation, is a normal running cost. Where such control methods are not carried out, or are done indifferently, losses may occur as the result of infestation of the finished products or by blockage of machinery in the flour mill. Costs can be reduced by the use of machinery specially designed to reduce the amount of insect harbourage (2, 3).

(10) *Costs of insecticidal treatment.* The cost of measures of prevention should be regarded as insurance but the cost of treatment and reconditioning of infested commodities and in the treatment of warehouses must be regarded as losses.

(11) *Losses due to injury to human beings and animals.* Any illness, whether of human beings or of animals, involves some loss, whether the cost is borne by the individual or by insurance. – Difficulties occur regularly in the docks regarding the discharge of infested cargoes, particularly when these are of a kind liable to cause dermatitis or conjunctivitis, and this is often recognised by extra payment for handling such cargoes.

(12) *Losses due to legal process.* Those who sell infested food run the risk of being fined under various laws, such as the U.K. Food and Drugs Act 1938. For example during 1948 a firm of bakers was fined £88 and £9

costs on a series of summonses arising out of the sale of bread in which dead flour beetles were found (1). Severe penalties for failure to notify the authorities of infestation of food can also be imposed under the Prevention of Damage by Pests Act 1949.

(13) *Indirect losses.* In highly developed countries considerable financial losses occur as the result of loss of trade due to the discovery by customers of infestation in goods supplied to them and by publicity resulting from legal proceedings. This is particularly true of branded goods.

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DISCUSSION

Mr. **Nesbitt**: Have you any evidence of Tyroglyphid mites causing gastro intestine troubles in Great Brittain?

Mr. **Free man**: There are many reports that this is so but no definite reliable evidence.

DIE AUSBREITUNG DER TERMITE RETICULITERMES FLAVIPES(Kollar) IN HAMBURG

von
Herbert WEIDNER
Hamburg, Deutschland

Durch Schiffsladungen werden bekanntlich nicht selten schädliche Insekten verschleppt, von denen viele sich über grössere Gebiete, ja vielfach sogar fast über die ganze Erde verbreitet haben. Haus- und Vorratsschädlinge sind dafür besonders geeignet. So ist auch in der Stadt Hamburg die Zahl dieser Einwanderer und Neubürger gross. Sie umfasst vor allem die für die Kulturwüste spezifischen Arten, wobei unter Kulturwüste das durch die menschliche Kultur vegetationslos gewordene Gelände zu verstehen ist. Es sind dies zur Zeit in Hamburg gut 50 verschiedene Insektenarten. Manche von ihnen dürften schon in den ältesten Zeiten eingewandert sein, während andere erst in den letzten Jahrzehnten auftauchten und in Kürze sich ausserordentlich verbreitet haben. *Ptinus tectus* Boield, z.B. gehört hierher, der 1916 zum ersten Mal in Hamburg gefunden wurde und jetzt eines der häufigsten Hausinsekten ist. Bei anderen hinwiederum, die an extreme ökologische Verhältnisse gebunden sind, wie *Thermobia domestica* Pack., ein Bewohner der wärmsten Stellen in Bäckereien, geht die Ausbreitung nur sehr langsam vor sich. Gefährlich sind besonders solche Arten, die sich an das Klima anpassen können. So kam vor dem letzten Krieg *Acanthoscelides obtectus* Say. nur auf Lagern vor, während er im Krieg oder in der ersten Nachkriegszeit auch in Hamburg dazu übergegangen ist, die Bohnen bereits auf dem Feld zu befallen.

Besonders interessant in dieser Beziehung ist die Einbürgerung der nordamerikanischen Termite *Reticulitermes flavipes* (Kollar) in Hamburg. Sie ist beheimatet in den südlichen Staaten von U.S.A., wo sie etwa am 38. Breitengrad ihre Nordgrenze findet. Als Haustermite wird sie dort gefürchtet und oft recht schädlich. Nach Europa wurde sie bereits mehrfach verschleppt, ja, sie wurde sogar hier zuerst entdeckt und beschrieben, als sie in einem Gewächshaus zu Schönbrunn bei Wien als Schädling auftrat. Auch nach Frankreich wurde sie verschleppt und bei Bordeaux eingebürgert und schädlich. Während im ersten Fall die abnorm warme Gewächshaustemperatur ihr Fortkommen günstig beeinflusst hat und das Klima der Umgebung von Bordeaux, das zu den wärmsten von Mitteleuropa gehört, dem ihrer Heimat nahe kommt, so zeigt ihr Vorkommen in Hamburg, dass sie sich auch an ein bedeutend kühleres Klima anpassen kann. Obwohl die mittlere Jahrestemperatur in Hamburg bedeutend höher ist, als nach seiner geographischen Breite zu erwarten wäre, (sie beträgt infolge der Einwirkung des Golfstromes + 8,3°C, während

der theoretisch errechnete Wert nur bei + 3,5°C liegt) so ist doch die Zahl der Frosttage mit einem Kälteminimum unter 0°C : 76,7.

1937 wurden die Termiten zum ersten Mal in Hamburg gefunden. In einem Einsteigschacht zu den Rohren der Fernheizung vor dem Oberlandesgericht am Sievekingsplatz legte ein Arbeiter, der eine Reparatur vornehmen musste, seine Jacke über eines der Abstützbretter. Durch diese geringe Belastung fiel es in sich zusammen. Es war innen ausgefressen, zum Teil mit Erde wieder ausgefüllt und enthielt zahlreiche Termiten: Arbeiter, Larven, Geschlechtstiere mit Flügelanlagen und wenige Soldaten. Alle Abstützbretter des Schachtes erwiesen sich als mehr oder weniger stark befallen. Der Fernheizschacht bot den Termiten einen idealen Brutplatz, da es in ihm auch im Winter warm ist – man kann auf der Strasse nach einem Schneefall an den abgeschmolzenen Streifen den Verlauf der Schächte verfolgen. Wäre dieser Fall allein geblieben, so wäre er wohl eine Merkwürdigkeit gewesen, hätte kaum aber wissenschaftliches oder praktisches Interesse zu beanspruchen gehabt.

Von 1939 bis 1943 wurde dann eine Anzahl Termitenschäden in den Häusern einer Seite des Pilatuspool festgestellt, und zwar bis auf eine Ausnahme in den Erdgeschosswohnungen. Der erste Fall wurde entdeckt durch einen 80 cm langen Erdtunnel, den die Termiten zwischen Fensterbrett und Fussbodenleisten an der Wand entlang gebaut hatten. Frasschäden in der Fensterfüllung waren vorhanden, aber gering. Grössere Frasschäden wurden im September 1940 ebenfalls in der Fensterfüllung in der Erdgeschosswohnung eines anderen Hauses entdeckt, die durch einen Flaksplitter zerstört worden war. Das zerfressene Holz war Eiche. Noch bedenklicher war der Fund einer Kolonie im August 1941 in der Erde und den Brettern eines erst im ersten Kriegsjahr erbauten Splitterschutzes wieder eines anderen Hauses in derselben Strasse. Auch hinter der Türfüllung und den Fussleisten des hinter ihm gelegenen Hausflures wurden Termiten gefunden. Hiermit war nun der Beweis erbracht, dass die Termiten sich in Hamburg vermehrt und neue Kolonien gegründet hatten. Schon im nächsten September wurde in einem anderen Haus eine grössere Kolonie im Holzwerk des Fensters gefunden, diesmal im Obererdgeschoss, die auch erhebliche Frasschäden verursacht hatte. Das Hauptnest lag in einem Befestigungsklotz des Fensters, der aus Kiefer bestand und vollständig zerstört war. Von ihm aus konnten Frassgänge und Erdtunnels über das ganze Holzwerk hin verfolgt werden. Beachtenswert ist, dass in allen diesen Häusern keine Fernheizung vorhanden ist, allerdings laufen die Fernheizschächte in nicht allzu grosser Entfernung durch die Häuser der Nachbarstrasse. Nach dem Krieg und den sehr kalten Wintern der Nachkriegsjahre, in denen vielfach Heizungsmangel herrschte, konnten im Winter 1950 abermals mehrere Termitenkolonien in einer Erdgeschosswohnung dieser Strasse festgestellt werden. Entdeckt wurden die Schäden durch Renovierungsarbeiten. Sie zeigten bereits ein erstaunliches Mass der Zerstörung. Es waren je zwei Fenster- und Türumrahmungen in der Vorder- und Hinterfront des Hauses, die Fussbodenleisten der Hinterzimmer, des Abort-

raumes und des Flures, sowie die Verschalung einer Zwischentüre und ein Stück des Fussbodens zerstört, dazu zeigten sich die Termiten auch noch in einem im Hof gefällten Baum, aber nach Aussage des Gärtners erst einige Zeit, nachdem er gefällt war. Praktisch war hier das ganze mit dem Erdboden oder dem Mauerwerk in direkter Berührung stehende Holz zerstört. Der Vollständigkeit halber sei auch erwähnt, dass in dem an diese Häuserreihe sich anschliessenden Hochhaus, das von der Fernheizung versorgt wird, im März 1942 Termiten aufgetreten sind, wo sie in den Fernheizschächten Erdröhren gebaut haben und aus den Korkunterlagen von im Keller montierten elektrischen Maschinen hervorgekommen sind. Sehr interessant ist auch ein Fund, der im Frühjahr 1951 gemacht wurde. In einem Haus der Parallelstrasse zum Pilatuspool, dem Holstenwall, bauten die Termiten aus einem kleinen Riss im Zementfussboden des Kellers ihre Gänge heraus. Das Haus ist erst vor einem halben Jahr bezugsfertig geworden. Es war jahrelang als Ruine ungestört gelegen. Die Termiten müssen sich in Holzstückchen, die von den Fenstern oder Türen des durch Bomben zerstörten Hauses herrühren, eingenistet haben und mit diesen in Hohlräume unter den Betonfussboden des Kellers gekommen sein. Auch hier muss der Befall im Freien stattgefunden haben.

Wie die Termiten nach Hamburg gekommen sind, lässt sich nicht mehr rekonstruieren. Es ist fraglich, ob der Fund in dem Einsteigeschacht der Fernheizung wirklich das erste Auftreten der Termiten in Hamburg und damit die Ansteckquelle für die genannten Häuser darstellt; denn bereits einige Jahre vorher wurden schon von anderer Seite in der Speckstrasse Termiten festgestellt, allerdings ohne, dass die Art bestimmt wurde. Die genannte Strasse ist nicht allzu weit von dem Einsteigeschacht der Fernheizung und dem Pilatuspool entfernt. In diesem Jahr wurde nun noch ein Termitenauftreten in einer Gastwirtschaft der Ulricusstrasse festgestellt, wo die Termiten aus einem Deckenbalken heraus freie nach unten hängende Röhren gebaut haben. Diese Strasse liegt ziemlich in der Mitte zwischen den anderen Fundorten, so dass man auf eine weitere und regelmässige Verbreitung der Termiten in diesem Stadtteil schliessen muss. Diese Verbreitung kann aber nur durch fliegende Geschlechtstiere erfolgt sein. Allerdings konnten solche in Hamburg bisher noch nicht erhalten werden. Auch unter den Tieren, die ich in Zucht genommen habe, sind noch keine entstanden. Das Auffinden der Termiten ist deshalb besonders schwierig, weil sie wegen ihrer heimlichen Lebensweise selten gesehen und vom Laien vielfach nicht beachtet werden.

Die festgestellten Termitenschäden wurden immer sofort beseitigt, meistens durch Verbrennen der zerfressenen Holzteile, umherlaufende Tiere wurden mit Pyrethrumpulver, Folidol oder DDT-Staub abgetötet, das frisch eingebaute Holz wurde, soweit es nicht durch Stein ersetzt wurde, mit einem Holzschutzmittel imprägniert. An allen Stellen, wo die Termiten bekämpft wurden, sind keine neuen Schäden mehr festgestellt worden. Trotz Aufklärung der Bevölkerung durch die Tageszeitungen und Flugblätter ist doch noch

damit zu rechnen, dass weitere Schadauftreten festgestellt werden. Wie die vorliegenden Funde beweisen, sind die Termiten in Hamburg nicht nur eine Merkwürdigkeit, sondern eine ernst zu nehmende Gefahr für den Grundbesitz. Es ist dies wieder ein Beispiel dafür, wie leicht doch durch Einschleppung neue Schädlinge auftreten können und unterstützt die Forderung nach einer Beaufsichtigung der Einfuhr zur Verhinderung der Einschleppung schädlicher Insekten.

THE HABITS AND CONTROL OF BLOWFLIES IN A SLAUGHTERHOUSE

by

E. A. PARKIN
Slough, England

Introduction

Blowflies which are attracted to slaughterhouses and breed to enormous numbers in the refuse available there have long been a problem each summer. Knowledge of the residual effect of DDT films on flies and mosquitos raised the hope that the occurrence of blowflies in slaughterhouses could be reduced by the application of such films to the internal building surfaces. Practical trial showed that this was not successful and in 1947 the Pest Infestation Laboratory was asked to investigate the whole problem. Most of the experimental work done since then has been concentrated at a large slaughterhouse in southern England, although many others have been inspected; one of the first observations made was that the DDT wettable-powder treatment had failed simply because the blowflies did not settle on the internal surfaces of the buildings. The large numbers of blowflies at this slaughterhouse were a great nuisance to the workers there, and in the surrounding district blowflies were all too common in houses and shops. A certain amount of meat became infested and waste material removed from the yard to be processed into animal feeding stuffs, fertilizer, glue, etc. was extremely heavily infested.

Importance was also given to the work by the growing amount of evidence [TRASK et al. (1943), MELNICK and PENNER (1947)] that *Phormia regina* and *Lucilia sericata* can transmit poliomyelitis, in addition to various enteric infections.

It was the purpose of this research to investigate the biology of the blowflies in the field and in the laboratory and to combine the knowledge gained with a knowledge of insecticides and their application in order to bring about reduction of the infestation. The detailed results of this investigation are being published by GREEN (1951a,b).

The blowfly population

Blowflies were found to hibernate in the soil as fully grown larvae which pupated early in spring. When the weather was warm, the adult flies oviposited profusely on slaughterhouse refuse and the population increased with remarkable rapidity. The important species present were *Calliphora erythrocephala* (Meig.), *C. vomitoria* (L.), *Lucilia caesar* (L.), *L. illustris* (Meig.), *L. sericata* (Meig.), and *Phormia terrae-novae* (R.-D.). *Lucilia* spp. normally represented about 80% of the population and 95% of them were *L. sericata*. Dr F. VAN EMDEN very kindly made the identifications for us.

It was clear that breeding on the premises in the summer season accounted for the great majority of the flies present, but when local breeding was eventually eliminated, a population remained which represented a steady flow to the slaughterhouse of flies breeding in the surrounding district, probably in garbage bins.

Observation of the blowflies in the slaughterhouse yard revealed that at night and in cool weather they rested near the base of vegetation covering a piece of waste ground just behind the concrete yard in which the slaughterhouse refuse was tipped to await collection. As the day grew warmer, the flies crawled up the stems of the taller plants and later began to migrate in large numbers to feed and to oviposit on the refuse. In hot, sunny weather they went farther afield and many rested on the sunlit walls of the buildings or entered open doors and windows, thus gaining access to the carcasses. They would readily congregate for feeding on carcasses hanging in sunlight but about 98% of blowflies caught in the dimly lit sheds and hanging rooms were ovipositing females.

No attempt was made to estimate the blowfly population of the slaughterhouse premises because of its non-uniform distribution and its rapid changes in relation to the weather and to the amount of slaughtering in progress.

Breeding habits

Oviposition started 3 to 7 days, according to the species, after emergence of the adults, the eggs being laid in batches of 10 to 300 and usually being inserted deeply into crevices of the slaughterhouse refuse where the relative humidity would remain high, for the eggs are very susceptible to desiccation. Females laid up to 1200-2200 eggs according to species. The eggs hatched within 16 hr. and the young larvae soon tunnelled away from the oviposition site. Dense larval populations were common: in one experiment nearly 76.000 larvae grew to maturity in 45 lb. (20 kg.) of refuse i.e. 4,000,000 blowflies per ton of refuse. The *Lucilia* were usually the first to suffer from the pressure of excessive population densities; and *Phormia* the last because of their very predaceous habits. Under favourable conditions of fermentation temperatures in the food, larvae became fully grown and migrated from the food for pupation within 3 days of oviposition.

Larval migration occurred mainly at night and the larvae pupated 1-3 in. (2.5-7.6 cm.) deep in the soil within a few feet of the breeding material, but they have been observed to wander up to 100 feet (30 m.). The pupal period occupied 4 days or more according to weather conditions. The larvae remained in the soil in a prepupal state during the winter. They were not immobile in this stage as they would burrow more deeply in very cold weather or come to the surface if the ground became waterlogged. *Calliphora* and *Phormia* flies emerged from the soil during March in 1948 and 1949 but during January in the mild winter of 1950. *Lucilia* were not seen before mid-April in any of the three years, but their numbers then increased so rapidly that they soon became the dominant species.

Control

Reduction of the blowfly population of this slaughterhouse to a level of unimportance was achieved by basing control measures, including hygiene and insecticides, on the biological information gained. Knowing that the minimum period between oviposition and migration of the mature larvae was 3 days, the concrete yard in which the refuse was tipped was divided by brick walls into three parts and a scheme of rotational storage and removal organized so that no refuse remained on the premises more than 2 days. Care was also taken to see that each compartment was completely emptied and washed out before refilling.

Because the refuse in the concrete yard was obviously a focal point for blowflies to feed and to oviposit, it was dusted daily with a 5% DDT dust and the area of treatment was extended to include the surrounding ground and vegetation to a distance of 15 ft. (5 m.). The use of ovicides and larvicides was not investigated in detail, because of difficulties of mixing with the refuse and the need to avoid its excessive contamination, but observation showed that dusting the surface of the refuse heap daily reduced considerably the numbers of eggs deposited.

Since the majority of the adult blowflies on the premises used the vegetation on the waste ground as a resting place at night and in cool weather, this vegetation was treated every 6 weeks with a 5% DDT dust, after preliminary trials had shown that the blowflies were not repelled. This treatment was very successful, and it is interesting to note that similar results were obtained by BAKER & SCHWARTZ (1947), who used a DDT emulsion to treat vegetation which provided a night resting place for blowflies troublesome in a fishmarket. The population of adult blowflies was further reduced by regular dusting with DDT powder of small piles of hoofs, horns, and other special materials, which were very attractive to the insects, and by application of a DDT wettable powder to those sunlit outside walls of buildings on which flies, especially *Phormia*, had been observed to rest in some numbers.

In spite of all this treatment there remained a very small population of blowflies, but this was not troublesome and the conclusion was drawn that it represented the daily immigrant population which had bred not in the slaughterhouse but in the surrounding district and had then been attracted to the refuse.

In conclusion, it must be pointed out that the control measures described are those which were found most suitable and successful for the particular slaughterhouse. Some would probably not be applicable to other slaughterhouses and alternative measures would have to be tried such as screening of doors and windows, shading the hanging meat, treating the ground with an insecticidal dust or emulsion to kill pupating larvae and emerging blowflies, etc.

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DISCUSSION

Mr. **Vayssière:** Est-ce que les détritus végétaux traités aussi avec le DDT sont ensuite donnés comme nourriture aux animaux? Des expériences faites en Suisse ont permis de constater que des vaches nourries avec du fourrage traité n'étaient pas malade mais que leur lait était toxique.

Mr. **Parkin:** Treated vegetation on the waste ground is not eaten by animals and the small amount of DDT dust applied as a surface treatment to the heaps of slaughterhouse refuse involves no significant risk as little of this material is used for manufacture into animal feeding stuffs; in any event, the rate of dosage is very low in relation to the volume of refuse treated.

Mr. **Achttienribbe:** Have you noticed any resistance of flies against DDT after a long time of treatment?

Mr. **Parkin:** So far no sign of resistance of blowflies to DDT has appeared, but strains of slightly resistant houseflies are known in England.

Mr. **D. W. Williams:** Do you find that the fly breeding season is extended in such places where there is warm material on which they can oviposit?

Mr. **Parkin:** Yes, but only a little because if adult flies emerge their activity is poor because of the low atmospheric temperatures.

OBSERVATIONS ON THE WEIGHT OF ADULT RICE WEEVIL, SITOPHILUS ORYZAE (L.)

by

D. BAP REDDY *)

Hyderabad State, India

In early experiments it was noticed that some weevils were less resistant to adverse environmental conditions than others, although they were approximately of the same age. It was also observed that less resistant weevils were smaller and lighter. It was thought that the variation in resistance to unfavourable situations was correlated with the variation in the weight of individuals.

Of the several factors which affect the weight of weevils food, moisture content of food and temperature are very important. RICHARDS (1948) has made a comprehensive study of factors which exert an influence upon the weight of the granary weevil. However, little information is available concerning these factors and their influence upon the weight and size of the rice weevil. In the early part of the investigation it was found that rice weevils exhibited variation in weight during their emergence and adult life. This variation in weight occurred in a sequence. Also, in case of the granary weevil a similar phenomenon was observed by RICHARDS (1948).

Weight-variations

Two experiments under varied conditions were conducted; one dealing with the weight-variations of the emerging progeny of mass and single cultures, and the other with the weight-variations during the adult life of weevils. Weevils used in the first experiment were reared on unpolished rice having a moisture content of 15.1 per cent and at constant temperatures of 26.6°, 30° and 32° C. Equal samples of rice were kept in each culture bottle and 50 females were placed in each bottle for 48 hours and then were removed. The newly emerging adults were weighed daily until all adults had emerged. Small vials with sealing wax stoppers were weighed on a chainomatic balance which had an accuracy of 1/1000 milligram. Before each weighing weevils were passed through different clean bottles and were brushed carefully to remove any particles of frass attached to their bodies. Each experiment and each weighing was replicated three times, throughout the investigation.

Weevils used to determine the weight-variations during the adult life were reared on wheat having moisture contents of 10.2, 13.2 and 17.6 per cent in equilibrium with a relative humidity of 60, 73, and 83 per cent respectively and at a constant temperature of 20°, 25°, 26.6°, 30°, and 32° C. Adults

*) Communicated by J.A.FREEMAN, England.

from each culture were weighed during their life at intervals of one or two weeks and at each weighing adults were placed in a new corresponding culture to avoid the increase in population. Each sample consisted of 50 individuals and the procedure of weighing of adults was followed as described above.

After an analysis of data it was found that the weight variation is independent of sex; male and female emerging weevils exhibited the same phenomenon. In general, however, females were slightly heavier than males. Under all conditions of cultures, normally weevils emerging the first part of the emergence period are light and those emerging the last part are lighter. The heaviest weevils emerge about the middle of the total emergence period when the maximum number of weevils also emerge per day. It should be pointed out here that adults emerging the first day weighed slightly more than those emerging the second-day, however, not enough to obscure the weight-change.

A study of changes in weight during the adult life showed a slight increase in weight of adults the first week which then was followed by increase in weight reaching the maximum in about two months. This weight is maintained for a long period, declining slightly a week or two before their death.

The weight of adults ranged from 1.10 to 1.48 mg., averaging 1.34 mg. The weight increase ranged from 1 to 11 per cent, averaging 5.8 per cent. Weevils increase in weight by about 4.5 per cent in about the first third of their life. In general lighter weevils and those with a longer emergence period tend to put on more weight, although not enough to influence the weight change. The sequence of weight-variation, however, is influenced by the conditions under which the cultures are maintained.

Temperature and Moisture

Temperature and moisture content of food not only influence the rate of development but also affect the weight of the weevil. The data for this experiment was obtained by using weevils which were reared for the previous experiment. Seventy five individuals from each culture were weighed during their life at varying intervals.

The weight of adults reared in rice having a moisture content of 15.1 per cent at 26.6° or 30° C is almost equal and those reared at 32° C are lighter. The data obtained from one week old adults reared in wheat having a moisture content of 17.6 per cent at different temperatures indicated that within the range of optimum temperature the difference in the weight of adults is very insignificant but above or below this range the weight of adults decreases.

The moisture content of food was found to affect the weight of weevils during emergence and adult life. In general the weight of adults increases with the increasing moisture content of food. The weight of one week old adults at 26.6° C was 1.26 mg. in wheat of 10.2 per cent moisture and 1.44 mg. in wheat of 17.6 per cent moisture. Adults reared from food of low moisture content are very light as compared to those reared from food of optimum moisture content or higher.

The temperature and moisture content of food interact in their influence upon the weight of adults. At a lower moisture content of food lower temperatures (within the developmental range) have a positive effect, increasing the weight of adults. At a higher moisture content of food, temperature above or below the optimum range have a retarding influence upon the weight of adults. This may be due to the inability of weevils to consume and convert more food into energy, because at lower or higher temperatures the activity of adults as well as the developing larvae is impaired to certain extent. Thus the weight of adults might be affected by the production of great quantities of carbon dioxide at temperatures above the optimum range or by slowing the metabolic processes at temperatures below the optimum.

Quality of food

KINOSHITA & ISHIKURA (1940), RICHARDS (1944), BIRCH (1946) and others have reported that when rice weevils were reared on different grains they differed in size and weight. It was also observed by the writer that weevils fed on corn were larger and heavier than those fed on wheat, other conditions being similar. It was believed that this was due to the kind and the quantity of food. Therefore it was thought desirable to determine what influence the quality of food might have upon the weight of adult rice weevils.

To obtain the same quantity and kind of food, White Federation wheat was used. Equal sized kernels were chosen and a portion of it was boiled in water for one hour and then was allowed to dry. The normal (unboiled) and the boiled wheat was brought into equilibrium with 70 per cent relative humidity which resulted in a moisture content of 13.6 per cent for the normal wheat and 12.2 per cent for the boiled wheat. Approximately equal quantities of each sample were placed in culture bottles with about equal number of females in each bottle and were placed at a constant temperature of 26.6° C and relative humidity of 70 per cent, and after two days females were removed and the cultures were left for incubation. After the emergence of weevils the wheat in each culture was replaced with corresponding wheat one week after the first weevils emerged and thereafter every two weeks for the duration of the experiment. Weevils which emerged from normal and boiled wheat were weighed separately in samples of 75 at varying intervals for four months.

Weevils emerged in 30 days from normal wheat whereas the development was delayed for 3 days in boiled wheat. This is because of the more favourable moisture content of normal wheat for the rapid development of weevils. However, adults developed from boiled wheat are heavier (1.39 mg) than those reared from normal wheat (1.20 mg). This occurred despite the fact that the moisture content of normal wheat (13.6 per cent) was more favourable for the development of weevils than that of boiled wheat (12.2 per cent). RICHARDS (1948) found that granary weevils reared from whole wheat macaroni were heavier than those reared from English-wheat.

The initial weight of adults from boiled wheat is more than the maximum

weight of adults from normal wheat. The boiling of wheat has resulted in the production of larger and heavier weevils. The per cent increase in weight of adults in four months, however, is slightly more in weevils from normal wheat, because lighter weevils tend to put on more weight.

The heavy weight of weevils reared and fed on boiled wheat is due neither to the influence of temperature nor of relative humidity. The difference in the moisture content of food as a factor in producing heavier adults from boiled wheat can be disregarded because the moisture content of boiled wheat is less favourable for weevil development and activity than that of normal wheat. The possibility of the effect of the quantity and the kind of food can be dispensed with because equal quantities of wheat of the same variety were used in both experiments. The heavier weight of adults from boiled wheat is probably due to the boiling of wheat which might have affected the nature and the quality of the wheat that was used as food.

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DISCUSSION

Mr. **Zacher**: Der Reiskäfer hat mehrere verschieden grosse Stämme von denen einer auch als *C. oryzae* var. *zea-mais* Motsch. bezeichnet wird. Es wäre interessant zu wissen welche Form der Vortragende gehabt hat.

LOCATION AND DETECTION OF EGGS IN THE GRAIN

by

D, BAP REDDY *)

Hyderabad State, India

Grain weevils, the rice weevil, *Sitophilus oryzae* (L.) and the granary weevil, *S. granarius* (L.), are the most important pests of stored grains and certain cereal products. Although these weevils differ in many ways they resemble each other closely in general form and biology. Both lay eggs inside the kernels and all the immature stages complete their development within the kernel, adults emerging after maturity.

Generally females excavate a small cavity in the kernel with their strong slender rostrum and turn around and lay a single egg which is plugged in the kernel with a gelatinous secretion. In a few minutes this plug or cap dries and due to its translucent property assumes the color of the portion of the kernel in which the egg is laid, making the detection of the egg very difficult. Normally weevils do not plug a cavity unless they lay an egg in it and also do not oviposit in the cavity without plugging it.

The egg plugs are very small and can hardly be seen with the naked eye. Therefore, in order to count accurately the number of eggs laid in infested grain special methods must be employed to detect the presence of the egg. Some experiments were conducted for the purpose of locating and detecting eggs of the rice and the granary weevils in rice, wheat, and corn.

Several methods have been used by different workers to detect eggs in grains. EASTHAM & McCULLY (1943) estimated the number of eggs on the basis of counts of egg plugs. EWER (1945) soaked the infested grain in 70 per cent ethyl alcohol for 24 hours. Then the testa was stripped off and the eggs were counted from the dissected grain. A staining method for detecting weevil infestation in grain was devised by FRANKENFELD (1948).

Because the methods of both EASTHAM & McCULLY and EWER consumed much time and involved a great deal of labour the procedure of FRANKENFELD was used. The latter used two methods for detecting weevil infestations in granaries. He used Lugol's solution and found it to be unsatisfactory and the same difficulty was experienced by the author. The other method as suggesred by FRANKENFELD involved the use of acid fuchsin. The solution of the dye used in these experiments was prepared in the following manner. Fifty cubic centimeters of glacial acetic acid was mixed with 950 cc of distilled water and then 0.3 gram acid fuchsin, which readily dissolved in the solution, was added. However, FRANKENFELD used 0.5 gram acid fuchsin in his experiments. The author has also used acid fuchsin solutions in water, in some experiments, without glacial acetic acid.

*) Communicated by G. van ROSSEM, Wageningen, Netherlands

For the determination of the egg plugs infested grain was treated as suggested by FRANKENFELD. The duration of treatment lasted from 2 to 10 minutes depending upon the kind, condition of the grain and the nature of the staining medium. When 0.3 gram dye is used 2 to 6 minutes time is sufficient to stain the egg plug, 4 minutes being the average. Rice, especially polished rice, stains rather quickly, hence should not be kept in the dye for more than 3 minutes. The solution of the dye without glacial acetic acid also serves the purpose of staining the egg plug but the time of treatment is longer. The advantage of using this solution is the fact that it does not stain the grain heavily and is very useful in treating rice. However, this solution is not satisfactory with corn and wheat because the treatment is prolonged by 10 minutes or so and the color intensity of the stained kernels is less than it is when glacial acetic acid is mixed with the solution. Therefore, the author recommends the use of glacial acetic acid with the solution.

Before examining the stained grain for the egg plug the excess dye is washed off with tap water and the grain is either drained or dried. Care must be exercised not to wash the stained grain under a forceful stream of water, lest some of the egg plugs be washed off, making the detection of those eggs difficult of which the egg plugs are washed off. The dye stains not only the egg plugs but also feeding punctures, mechanical injuries or any mutilation of the grain. However, with experience the egg plugs, feeding punctures, or mechanical injuries can be easily distinguished with the naked eye on the basis of the intensity of the color, the shape and the size. The egg plug stains a deep cherry red whereas the feeding punctures and the mechanical injuries are lighter in color. The egg plug is more or less regular in shape and is about the size of an ordinary pin-prick. In most cases, especially in wheat and rice, it appears rather elevated and looks like a small reddish abrasion on the surface of the kernel. The feeding punctures are circular in shape and the mechanical injuries are irregular.

Kernels of grain with stained spots can be easily separated from the treated cultures. Then these kernels are examined under a binocular for the verification of the presence of egg plugs. Upon removing the egg plug with a needle the eggs can be readily seen. Thus the number of eggs can be counted accurately by counting the number of egg plugs.

The dye was used on White Federation and Red Winter Hard wheat, corn and polished and unpolished rice. It was found satisfactory in all cases, except in polished rice in which case the whole kernel is heavily stained making the egg plug indistinguishable from the rest of the kernel. Generally the stigmatic end of a sound wheat kernel and germ end of a corn kernel absorb more stain than the rest of the kernel.

If the stained grain is kept for a long time the stain loses its intensity and may finally become indiscernable. The same dye solution can be used repeatedly for a long time until it becomes murky.

Some experiments were conducted to determine the location of the eggs on the kernel of the grain. In general female weevils choose a soft and

suitable spot on the kernel for oviposition. When wheat or rice was offered females showed a preference to lay eggs near the ends of the kernels, with a very slight preference for the stigmatic or hairy end. BACK & COTTON (1926) in the case of the granary weevil and MacLAGAN & DUNN (1936) in the case of the rice weevil reported a similar preference to oviposite near the hairy end of the wheat kernel. KAWANO (1939) observed that in rice the rice weevil oviposited more commonly on the middle portion. The results obtained by the author do not confirm the findings of KAWANO. In corn female weevils show a slight preference to oviposit near the germ end of the kernel, however, some eggs are laid also about the middle of the kernel. Generally one egg is laid per wheat or rice kernel but some times two or three eggs are deposited in a corn grain.

Acknowledgments

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DISCUSSION

Mr. **Easter**: Emphasis has been made in the U.S.A. to hold insect fragment counts to a minimum in flour. – The method of staining developed by Dr FRANKENFELD was intended among other uses to give millers a simple method of detecting internal infestation so that grain so infested could be avoided.

Mr. **Van Rossem**: FRANKENFELD's staining method is also in use at the Phytopathological Service (Wageningen–Netherlands). There is no doubt that this method is really suitable for the determination of *Calandra* infestations of wheat, corn, and sorghum. We found that in certain cases the method can also be applied in barley.

REMARKS ON ATTAGENUS SPECIES

by
Robert ZINKERNAGEL
Riehen/Basle, Switserland

In 1942 Warren and Marion B.MOORE published an article in the Journal of Economic Entomology, 35, 288, 1942, wherein they pointed out the fact that there existed two forms of larvae of *Attagenus piceus* (Olivier), one of them being chestnut brown and the other one silky yellow. Having found fundamental morphological differences between the two forms, W. and M.MOORE introduced them into the literature under the designations "yellow" and "black". For practical reasons we have examined the problem as to whether there is a real distinction between the yellows and the blacks, and we have found the following differences.

The most striking macroscopic difference is the dark brown colour of the black form, justly called chestnut brown by W.MOORE, in distinction from the red-brown to straw-coloured shade of the yellow form. Further microscopic differences can be observed in the setae covering the single segments of both forms.

The setae of the blacks are even, long, pointed and strongly pigmented, and they have two furrows in the longitudinal direction (fig. 1). The yellows have two different kinds of setae. There are a great number of lance-shaped and scaly setae that are hardly pigmented and have approximately five fine longitudinal furrows. The other setae are long, needle-shaped, hardly pigmented, and they have only one longitudinal furrow (fig. 2). The length of the setae varies according to the age of the larvae and with the segments. The sixth segment of the needle-shaped setae of middle aged larvae has an average length of 0.25 mm and an average width of 0.015 mm. The lancet-shaped setae are approximately 0.1 mm long and 0.02 mm wide. The length of the setae diminishes cranial-caudally, but it increases with the number of moults. The colour of the blacks appears dull whereas the yellows show distinct reflexions of light. This is due to the special shape of the setae.

Morphological differences can be observed chiefly between the male black and yellow imagines. Their last antennal segment is differently shaped and pigmented (fig. 3). The pigmentation of the blacks is dark-brown whereas it is light-brown for the yellows. The index of the length and width of the last antennal segment of the males appears characteristic to us. On taking measurements we obtained the following figures:

yellow, culture Geigy Basle	4.45 (± 0.47)
black, culture Geigy Basle	2.97 (± 0.27)
Attagenus pellio, found out of doors	3.25 (± 0.30)

These results were obtained from 50 individuals of each type. The dif-

Fig. 1

Fig. 2

Fig. 1. *Attagenus* "black", culture Geigy Basle, 7. abdominal segment sternite
Fig. 2. *Attagenus* "yellow", culture Geigy Basle, 6. abdominal segment sternite

Fig. 3

Fig. 4

Fig. 3. right: *Attagenus* "black", culture Geigy Basle, antenna of the adult male;
left: *Attagenus* "yellow", culture Geigy Basle, antenna of the adult male.
Fig. 4. right: *Attagenus* "black", culture Geigy Basle, antenna of the adult female;
left: *Attagenus* "yellow", culture Geigy Basle, antenna of the adult female.

ferences are covered statistically. The index of the length and width of the antennae of the females is the same for both types; there is, however, a difference in the pigmentation (fig. 4). The three last antennal segments of the blacks are more pigmented than those of the yellows.

Physiological differences between the blacks and the yellows are particularly evident when the larvae are fed on wool. On normal sheep's wool that has not been specially prepared, the yellows do not develop up to their adult stage; the development is slowly brought to a stop in the larval stage. In contradistinction to this pure sheep's wool is sufficient for the complete, but slow, development of the blacks. The yellows develop on wool to which rabbit blood or yeast has been added, but this is still very slow when compared with the blacks. The development of both forms is much more rapid on cereals such as dog biscuits. But even here the development of the blacks is more rapid than that of the yellows.

For both forms the average amount of moults is 11. There is no difference between the sexes in this respect. The intervals between the moults become longer with the increasing number of moults. In particular, the last or the two last intervals between the moults can be very long. The following total larval stage counted in days was found for both forms:

black males	336.3 ± 35.3	black females	328.8 ± 22.9
yellow males	298.1 ± 29.6	yellow females	295.7 ± 27.8

The determination of the value of t shows that for both forms there is no difference between the average larval stage of the males and females. There is, however, a difference in the larval stage between the black and yellow males and the black and yellow females.

The average weight of the blacks is higher than that of the yellows. This corresponds to their longer larval stage.

Weight of larvae, pupae and beetles in mgrm.

Form:	Moulting intervals: 5.	6.	7.	8.	9.	10.	11.	12.	Weight of pupa:	Weight of beetle:
yellow ♂	0.5	0.9	1.4	2.1	3.4	4.1	4.4		6:0	5.2 ± 0.63
yellow ♀	0.6	0.93	1.65	2.7	4.4	6.3	7.9		10.0	9.2 ± 2.17
black ♂	0.7	1.47	2.9	4.4	5.5	6.4	7.0	8.0	8.0	7.0 ± 1.27
black ♀	1.0	2.4	4.3	7.5	9.9	11.6	11.8		14.4	13.3 ± 1.21

The quantity of food needed by the larvae corresponds to their weight. The blacks need more food than the yellows.

Quantity of food in mgrm			Food basis Gain's Dog Food	
males	black	43.9 ± 8.5	yellow	28.0 ± 5.2
females	black	67.9 ± 7.8	yellow	48.3 ± 12.5

The quantity of the excrement of the blacks is also bigger than that of the yellows.

We have conducted over 1.000 crossing experiments with individuals from

seven different cultures and in 48 out of 49 possible combinations we have found that the cross breeding of black beetles from different cultures was always successful, the same applies to cross breedings of yellows and yellows. No reproduction occurs, however, when blacks and yellows are crossed. We observed one exception, however, where there were embryonic and larval developments in a few single sets of eggs. This case is still being examined.

The observations point to the fact that the yellow and black forms must be two different species. We have laid our observations – as far as they have been completed – before the British Museum, Nat. Hist., Dept. of Entomology, and this Institution has confirmed our observations.

Our tests were made to ascertain whether the different *Attagenus*-larvae used in the trials, all of which come from *Attagenus piceus* cultures, produce sufficiently uniform larvae for test purposes. We are forced to the conclusion that at least two different species are used. Our tests show that the blacks consume much greater quantities of food than the yellows, even when experimenting with larvae of practically the same age and weight. This is also true with regard to the excrements. In order to obtain a uniform basis for comparative tests with *Attagenus piceus*, it is absolutely necessary to distinguish between the yellow and the black forms. Furthermore the establishment of a central culture and the constant renewal of the cultures in the testing laboratories must be taken into consideration.

[Particulars will be published elsewhere.]

DISCUSSION

Mr. **Zacher**: Der Vortragende zeigte dass morphologische Unterschiede der Larven bestehen. Es ist klar dass wir nur konventionell die Systematik auf das Imagostadium begründen. Merkmale der Larven sind für die Systematik ebenso wichtig und entscheidend.

Mr. **D.W.Williams**: Physiological differencies are very important in stored products insects. Similar conditions exist among Nematodes of domestic animals and man. Morphologically identical species such as *Ascaris lumbricoides* and *Ascaris suis* show important physiological differences. It seems important to recognise such differences where they exist in stored products insects. Physiological differences are more important than morphological ones where insect control is concerned.

Mr. **Zinkernagel**: I agree with Dr WILLIAMS as far as the morphological descriptions can not give all differences which we need for being able to separate one special form from another. Not only the invertebrates, also the vertebrates give us examples.

Mr. **Parkin**: Do both yellow and black forms occur in Europe in warehouses, etc.?

Mr. **Zinkernagel**: Up to now we never had the chance to find the yellow form in Europe in warehouses or other places.

Mr. **Solomon**: The relationship between the forms of ***Attagenus piceus*** is reminiscent in some ways of that between the two strains of ***Calandra oryzae*** described by RICHARDS and by BIRCH. The two storage species of ***Oryzaephilus*** are closely similar in most respects. Some years ago, ***Ephestia elutella*** became a pest of grain, apparently as a new habit. Are these signs of a relative instability of some of the species associated with human society? We have created new habitats and have transported pests from region to region. Has this given rise to a recent and rather rapid formation of new forms?

Mr. **Zinkernagel**: I do not believe that human society has an influence on the development of new forms or species. The conditions which human society "offers" the insects will give a chance to such physiological strains of a species which can adapt to special conditions and develop on a large scale (such strains can be identical from the point of view of the taxonomist).

Mr. **Meeuse**: Since the St Gall "blacks" probably belong to a third species I should like to learn their origin.

Mr. **Zinkernagel**: St Gall "blacks" come from a culture which has been started by T.WALCHEI (EMPA, St Gallen) out of *Attagenus piceus*-beetles taken in the environment of St Gallen, Switzerland.

Mr. **D.W.Hall**: Since *Attagenus* "blacks" and *Attagenus* "yellows" are thought to be different species an investigation of the cytology of these might definitely confirm or disprove this. Have any cytological investigation such as comparison of chromosome numbers or structures been carried out?

Mr. **Zinkernagel**: No cytological work has been done on these forms of *Attagenus* species.

PROTECTION ET DESINFESTATION DU BLE EMMAGASINE PAR DES SUBSTANCES NON-TOXIQUES

par
Remo GRANDORI
Milan, Italie

Depuis les anciennes âges, les Egyptiens employaient la poudre du désert pour protéger le blé de l'attaque des insectes. Dans l'époque moderne, on emploie des farines fossiles ou des poudres silicieuses, qui ont le défaut de s'agglomérer lorsque l'humidité ambiante est supérieure au dégré normal, avec une diminution ou perte totale d'efficacité. Le problème n'est donc pas encore résolu, du moins pour l'Italie et d'autres pays européens.

Une solution complète du problème doit répondre aux 3 conditions suivantes: a) empêcher l'installation des insectes dans le blé avant son entrée dans le magasin; b) désinfester le blé s'il est déjà infesté lorsqu'il passe en magasin; c) le protéger en manière permanente contre des infestations successives.

Nous avions observé dans l'année 1948 que des adultes de *Blatta orientalis*, poudroyés avec une benthonite italienne, étaient tués en quelques heures, et que plusieurs espèces d'insectes parasites du blé, à l'état larvaire ou d'adulte, mouraient également lorsqu'on mélangeait au blé un pourcentage variable de la même poudre. Nous avons pensé alors que cette substance pouvait représenter une solution pratique et économique du problème du blé contre l'attaque des insectes.

Beaucoup de mines de benthonite existent dans le monde, mais la composition minéralogique des différents types est très variable. Celle de S.Severo Puglia que nous avons expérimentée, présente l'efficacité la plus complète; sa composition résulte pour 26% de silex, 65% de montmorillonite, et 9% de substances accessoires. Les benthonites trouvent dans l'industrie beaucoup d'applications et d'emplois, y compris celui de support d'insecticides mais personne n'avait jamais observé avant nous qu'une benthonite, employée toute seule, telle qu'elle vient de la mine, avait propriété insecticide. La technique de l'application est très simple: on mélange la poudre avec le blé à 2‰ (200 gr. de poudre pour 100 kilos de blé).

Nous ne voulons pas rapporter ici les centaines d'essais qui furent nécessaires pour établir les doses, la durée d'action, les conditions d'humidité et de température, l'efficacité sur les insectes du blé dans une ambiance libre ou obligée, en présence ou en absence du céréale, en comparaison avec des autres poudres toxiques ou non-toxiques. Ces essais ont été déjà exposés en détail par des publications précédentes. Nous nous bornons ici à résumer les faits essentiels.

La benthonite montre une action mortelle sur les adultes des espèces suivantes: *Sitotroga cerealella, Tinea granella, Plodia interpunctella, Ory-*

zaephilus surinamensis, Tenebrioides mauritanicus, Calandra granaria, Calandra oryzae, Rhizopertha dominica, Laemophloeus ferrugineus. Toutes ces espèces meurent entre quelques heures, ou dans la journée suivant l'application de la poudre; exceptée *Calandra granaria*, qui est douée d'une résistance particulière, mais elle meurt également dans une semaine au maximum.

Les larves qui sont à l'extérieur des grains, touchées par la poudre, sont elles-mêmes condamnées à la mort; celles qui vivent à l'intérieur des grains, vont subir la même destinée lorsqu'elles sortiront des grains qui les hospitalisaient.

Le premier effet de la benthonite est un effet insectifuge: les insectes touchés par la poudre s'éloignent du blé et ils n'y retournent plus. Mais ceux-la peuvent survivre qui se trouvent dans la couche superficielle, et ont pu s'enfuir rapidement, n'ayant subi l'action de la poudre que pour quelques minutes. Ceux qui étaient dans les couches profondes, ayant subi plus longtemps l'effet de la poudre, peuvent en quelques cas s'éloigner, mais ils meurent en quelques jours, comme on peut démontrer en les recueillant et en les plaçant en contact avec le blé normal.

En tout cas, l'insecte subit évidemment un amoindrissement dans les actes inhérents à la fonction de reproduction, et il devient incapable de donner progéniture.

Pour obtenir un effet total, pour éviter que l'action insectifuge laisse survivre un petit pourcentage d'insectes qui s'enfuie trop tôt, nous avons pensé à une action combinée du poudrage du blé et d'une désinfestation des parois du magasin par le DDT, de façon que l'insecte qui s'enfuit du blé sans avoir encore subi un action mortelle, doit mourir par le contact du DDT. De cette façon on évite toujours l'introduction du poison dans le blé; cette méthode nous a donné toujours des résultats de désinfestation complète de quantités variables de 1 à 45 kilos de blé en laboratoire.

Après avoir établi la dose optimum de benthonite à 2‰ et l'optimum du dégré de finesse à 12.000 mailles, nous avons jugé nécéssaire d'affronter l'expérimentation dans l'ambiance agricole, dans des grandes masses de blé, c'est à dire dans les conditions naturelles dans lesquelles la nouvelle méthode devait être appliquée.

Voici, en résumé, nos essais dans l'ambiance rurale:

1er essai (1949) - Dans une ferme près de Modena nous avons poudré avec benthonite BB 12 à 2 ‰, 14 Q. de blé à grain très infesté par *Calandra granaria.* Les parois du magasin avaient été préalablement désinfestées par DDT. Après 64 jours nous avons obtenu désinfestation complète du blé, dans lequel on a constaté seulement des cadavres de Calandra adultes. Dans un autre magasin de la même ferme, 40 Q. de blé également infesté et non traité, après 64 jours étaient fourmillants de Calandra adultes. Des échantillons furent prélevés des deux lots, transportés en laboratoire et entretenus sous observation; pendant 4 mois le premier échantillon est resté indemne d'infestation, le deuxième de plus en plus fourmillant d'insectes.

2me essai (1950) - Près de Cremona, dans un silo préalablement désinfesté par

DDT, nous avons introduit 150 Q. de blé, bien infesté par *Calandra granaria*, poudré avec benthonite BB 12 à 2 ‰. Après les 4 mois d'été, le blé, enlevé du silo, était complètement désinfesté.

3me essai (1950) - Dans un magasin près de Pavia, désinfesté par DDT on a introduit 500 Q. de blé infesté par *Calandra granaria* et *Tenebrioides mauritanicus* poudré avec benthonite BB 12 a 1 ‰. Après 4 mois d'été on a trouvé dans le blé uniquement des cadavres de *Calandra* et *Tenebrioides.*

4me essai (1950-51) - Dans une ferme près de Rovato (Brescia) 500 Q. de blé étaient menacés de destruction totale par une très forte infestation de *Calandra granaria, Plodia interpunctella, Tinea granella.* Des adultes de toutes les 3 espèces fourmillaient en surface de la masse qui était aussi révêtue par des filures des teignes. Dans ces conditions si désespérées le propriétaire a voulu également essayer notre méthode; le blé, poudré avec BB 12 à 2 ‰, fût transporté dans des chambres désinfestées par DDT. Après 5 mois une commission de techniciens a été invitée par nous à visiter ce blé, et elle l'a trouvé presque totalement désinfesté. Seulement des rares chenilles de *Plodia* et de *Tinea* survivaient, ce qu'on peut bien expliquer parce qu'elles étaient protegées par la soie du cocon ou des filures; mais ces chénilles étaient condamnées à leur sortie à l'état de papillon. Cet essai a été jugé comme le plus démonstratif, parcequ'on a pu arrêter, dominer et presque anéantir une inféstation d'une gravité exceptionnelle.

5me essai (1950-51) - Dans un magasin désinfesté par DDT mélangé à Octaclor près de Romano di Lombardia, 100 Q. de blé très infesté par *Calandra, Tenebrioides, Oryzaephilus, Laemophloeus,* ont été poudrés avec BB 12 à 2 ‰. Un mois après, le blé, introduit en sacs a été conservé dans une autre chambre désinfestée par le même mélange. Six mois après le traitement, au control final, on a trouvé dans le blé des centaines d'insectes morts et pas un seul insecte vivant.

6me essai (1950-51) - Près de Bedizzole (Brescia) nous avons obtenu à notre disposition un magasin désinfesté par DDT et dans lequel nous avons introduit 1500 Q. de blé poudré avec benthonite BB 12 à 3 ‰ le 4 novembre 1950. L'infestation de *Calandra granaria* était bien évidente. Déjà un mois après, le blé était désinfesté; à la visite répétée chaque mois nous n'avons trouvé que des insectes morts; la commission des techniciens, à la visite du 18 Avril, à constaté seulement des cadavres de *Calandra*. Aujourd'hui, 8 mois après le traitement, la conservation du blé est parfaite, et il n'y a plus un seul insecte vivant. Les techniciens ont reconnu que, du point de vue entomologique, le problème de la désinfestation et de la défense permanente du blé contre les insectes peut être consideré – par cette méthode – comme résolu.

Le méchanisme d'action de la benthonite est – vraisemblablement – par déshydratation du corps de l'insecte, exercée par le silex.

La montmorillonite absorbe, vraisemblablement, l'eau, en fonctionnant comme réservoir, ce qui empêche l'agglomération. C'est un très heureux synergisme chimique. Une action simplement méchanique doit être expliquée par les particules de la poudre qui pénètrent dans les espaces articulaires, en produisant des abrasions et une réduction progressive de mobilité des

pièces articulées, y compris les machoires et les mandibules ce qui amène à l'impossibilité de l'alimentation. La faim et la soif, donc, sont entrainées par cette poudre, et par conséquent la mort. La benthonite n'a pas d'efficacité contre les insectes parasites des plantes vivantes, parcequ'il peuvent se réfournir d'eau aux dépenses de la plante.

Les conditions nécéssaires pour le bon succès sont les suivantes :
1) Un dégré d'humidité de la masse du blé non supérieur à 12,5 %, condition qu'on exige toujours pour une bonne conservation du blé dans le magasin.
2) Un degré d'infestation modeste, pas exagéré, parce que le blé très fortement infesté présente déjà une forte quantité de poudre constituée par les déjections des insectes et les débris de leur rongement; cette poudre, mélangée à la benthonite, provoque son agglomération et perte d'efficacité.

Conclusions.

Après nos essais en grande échelle, nous confirmons en manière définitive que la benthonite italienne BB 12, mélangée au blé en dose de 2‰, est capable de le désinfester complètement et de le conserver indemne d'infestations ultérieures, aussi dans les grandes masses en magasin. La benthonite ne s'agglomère pas, aussi dans un atmosphère qui présente 90 % d'humidité, tandis que les farines fossiles et silicieuses s'agglomèrent à un dégré d'humidité bien inférieur. Elle ne produit pas de *silicose*, maladie produite par les farines fossiles. Elle est tout à fait inoffensive à l'homme et aux animaux domestiques, et elle est régistrée dans la pharmacopée officielle pour confectionner médicaments d'usage intérieur.

La Benthonite exerce aussi un effet insecticide rapide, en quelques heures sur les espèces communes de *Larides* qui infestent les légumes en magasin (*Laria, Acanthoscelides*, etc.).

La benthonite, en Italie, a un prix très modéré, c'est pourquoi, le traitement est très économique, et il présente l'avantage inestimable d'éviter l'introduction d'une substance toxique quelconque dans le blé, ce qui est toujours très dangéreux pour la santé publique. En effet, l'expérimentation physiologique de ces dernières années démontre que des quantités aussi ultra-minimes de DDT ou de Gammaxane dans l'alimentation quotidienne s'accumulent dans les reins et dans le foie et l'élimination est seulement partielle. Un empoisonnement chronique, très dangéreux, et pourtant inévitable. Dans plusieurs pays l'introduction de substances toxiques dans le blé est défendue, et nous pensons que cette pratique devrait être défendue partout.

L'unique objection que des techniciens italiens ont opposé à la nouvelle méthode consiste dans une petite diminution du poids spécifique du blé poudré, le poids spécifique étant chez nous la base pour la détérmination du prix. Mais il est bien évident qu'une très simple convention peut suffire à compenser une pareille diminution. Peut être, l'objection cache des intérêts commerciaux; mais alors la parole d'un naturaliste réchercheur doit s'arrêter, parce que dans la sphère de son activité ne peuvent pas entrer des inté-

rêts quelconques, mais uniquement les résultats de l'expérimentation scientifique.

DISCUSSION

Mr. **Zinkernagel**: 1. Quelle est la relation entre la grosseur du grain et l'efficacité? 2. Quelle est la différence fondamentale par rapport à la méthode de Zacher à l'aide de sable de quartz?

Mr. **Grandori**: 1. L'efficacité de la poudre de benthonite est parfaite lorsque les grains de la poudre passent à travers un tamis qui porte 12.000 mailles (trous) par centimètre carré. Bien entendu que parmi les plus gros grains sont mélangés de nombreux grains qui sont bien plus petits. 2. Il y a quatre différences fondamentales entre la méthode avec du sable de quartz et celle de la benthonite: a) Pour 100 Kilos de blé sont nécessaires 500 gr. de sable de quartz, tandis que 200 gr. de benthonite sont suffisants. b) Le sable de quartz perd beaucoup de son efficacité lorsque l'humidité ambiante dépasse 50 %; la benthonite l'entretient aussi aux 90 % d'humidité et au delà. c) Le sable de quartz produit silicosis, tandis que la benthonite ne la provoque jamais. d) Le sable de quartz n'a pas d'effect insectifuge, tandis que la benthonite montre une puissante et permanente activité insectifuge.

Mr. **Sy**: 1. L'influence de l'humidité a-t-elle été expérimentée au laboratoire et dans la pratique? 2. Est-ce-que ces résultats des expériences de la pratique dans les régions sèches et humides et pendant l'été ou l'hiver ont été favorables?

Mr. **Grandori**: 1. L'influence de l'humidité a été expérimentée dans des chambres ordinaires en Laboratoire sur de petites quantités de blé (de 5 à 50 Kilos) et à la campagne dans des magasins (de 100 à 150.000 Kilos de blé). Dans tous les cas, pendant plusieurs mois de la durée des expériences, l'humidité a varié entre 60 et 90 %, sans aucune influence sur l'efficacité de la benthonite. 2. Dans les régions sèches ou humides, pendant l'été ou l'hiver, les résultats ont été toujours favorables sans exception, y comprises les conditions de l'hiver de la vallée du Po ou il y a des dizaines de journées de brouillard.

Mr. **Gasser**: 1. ZINKERNAGEL et GASSER ont publié dans Bull. Soc. Ent. Suisse (1945) un appareil approprié au mélange de poudre et de semences. 2. L'action ne dépend-elle que de la blessure de la cuticle ou bien la benthonite italienne a-t-elle encore une propriété hygroscopique?

Mr. **Grandori**: 1. Nous possédons la publication de ZINKERNAGEL et GASSER et connaissons la machine pour le dosage de la poudre à mélanger aux semences. On a commencé aussi en Italie la fabrication de semblables machines. 2. La blessure provoquée sur la cuticule joue sûrement son rôle parce-que sur les lignes de la blessure l'épaisseur de la cuticule s'amincit et l'absorption de l'eau sur ces lignes est facilitée. Mais cequi est plus important, c'est le frottement produit par les particules de poussière qui

pénètrent dans les espaces articulaires et réduisent de plus en plus la mobilité des pièces articulaires, jusqu'à empêcher graduellement les mouvements relatifs à l'alimentation, à l'accouplement et à la ponte des oeufs.

L'absorption de l'eau se fait sur toute la surface du corps de l'insecte, mais la benthonite italienne ne s'agglomère pas, parce-que la montmorillonite (65 % dans la benthonite) absorbe graduellement du silex (25 %) l'eau que celui-ci absorbe de l'insecte et l'entretient entre les couches moléculaires caractéristiques de sa structure (empaquetage). Ainsi la benthonite conserve sa finesse et ses propriétés aussi dans l'air à 90 % d'humidité.

Mr. **Evans**: In what manner is benthonite mixed with grain?

Mr. **Grandori**: By hand and also by special machines, or, it can be added to the grain stream passing on a band.

LE CHAUFFAGE PAR RAYONNEMENT INFRA-ROUGE DANS LA DESINSECTISATION DES CHATAIGNES

par
Marie-Claire et René-Guy BUSNEL
Paris, France

Introduction

Nous avons essayé d'obtenir la déstruction des insectes parasites de la chataigne *(Carpocapsa - Balaninus)* en utilisant la chaleur produite par le rayonnement infra-rouge [1]; nous avons construit au laboratoire un four anti-parasitaire permettant de réaliser des essais semi-agricoles, polyvalents, pouvant intéresser outre la chataigne, les céréales, les haricots, etc; ce sont les résultats des travaux sur les insectes de la chataigne que nous exposons ci-après; le procédé est également valable pour les champignons parasites, et l'expérimentation sur ce sujet a été publiée par ailleurs [2].

Principe de la méthode

Les Insectes, de tous les ordres et à leurs divers stades ont une température léthale comprise entre 44 et 57°C (± 5) selon qu'ils sont soumis à la chaleur sèche ou humide [3]. C'est le milieu intérieur qui doit être porté à cette température pour que la mort survienne par la coagulation des protéines. Quelque soit le mode de chauffage utilisé, il faut atteindre le seuil léthal du parasite dans son abri végétal, et l'intérêt est d'agir avec des systèmes de chauffage pénétrant rapidement les tissus végétaux, ce qui correspond spécifiquement aux propriétés des infra-rouges ou des di-électriques.

Intérêt du chauffage par rayonnement sur le chauffage par convection

Les procédés de chauffage par convection à l'air chaud, sec ou humide utilisés avec plus ou moins de succès dans d'autres cas sont lents: par exemple, pour la chataigne il faut maintenir celle-ci à 60°C pendant 150 minutes [4] pour atteindre le point léthal des insectes, alors qu'avec les rayons infra-rouges, selon la distance des lampes et la taille des chataignes, 45 à 90 secondes d'irridiation suffisent; pour le blé il faut 63 minutes pour amener à 60° par chaleur sèche, la température interne du grain (CHUKICHI HARU KAWA) [5] alors qu'il faut 40 à 90 secondes selon les grains avec les di-électriques (TARUTIN) [6] ou les infra-rouges [7-8].

La chaleur par convection n'échauffe pas les insectes parasites d'une manière spécifique. D'autre part les loges ou ils se trouvent forment un écran qui oblige à chauffer davantage pour atteindre la température léthale, fait signalé pour *Calandra oryzae* par TSUCHYA et KOSAKA [9]. Au contraire, le chauffage par rayonnement permet d'observer que les tissus de l'insecte s'échauffent plus rapidement que les tissus du grain. L'augmentation de température peut varier de 2 à 5°C. Nous l'avons noté pour toute une série d'in-

sectes parasites des divers grains; VOROBIEV [10], GRASSER et STAMPA [11] travaillant dans des conditions légèrement différentes ont également observé ce phénomène.

On peut expliquer ce fait par la plus grande absorption spectrale spécifique des tissus d'insectes par rapport aux tissus végétaux dont la nature chimique est très différente.

Du point de vue pratique, cette observation permet de ne porter la température interne des fruits ou des grains à traiter qu'à 52-53°C, laissant une marge de 5° environ qui donne 100% de mortalité des insectes aux stades larvaires.

Un autre avantage du chauffage par rayonnement par les infra-rouges, réside dans l'accumulation d'énergie du tissu végétal: celle-ci se manifeste par l'augmentation de la température pendant un temps plus ou moins long, après l'arrêt du rayonnement. Pour la chataigne, cette augmentation de température se manifeste au coeur du fruit pendant 10 à 40 secondes après irradiation, selon la taille du fruit, et peut atteindre de 3 a 8°C. Le maintien en étuve après le passage sous les lampes d'irradiation permet ainsi d'entretenir la température léthale recherchée, et économise 10% d'énergie environ, ce que ne permet pas le chauffage par convection (graphique n° 1).

Méthode d'étude et de contrôle des chataignes

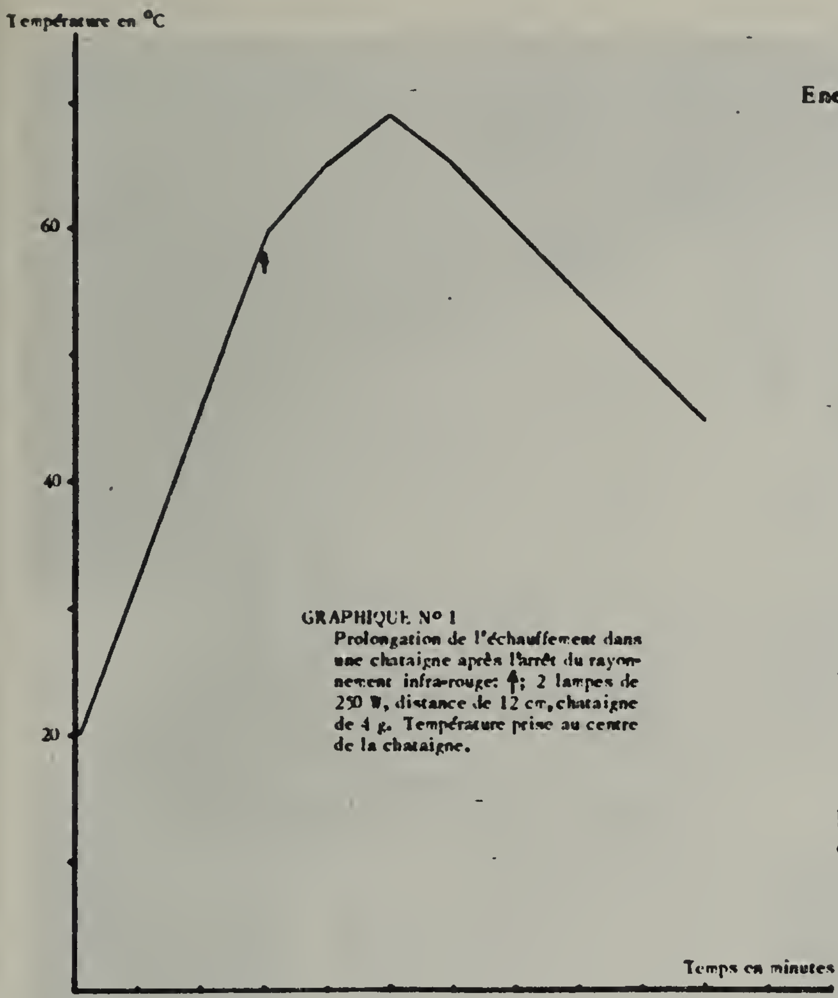
Nous avons utilisé des lampes de 250 watts, type parabolique, fabriquées par la Compagnie des lampes et dont la répartition d'énergie à partir de l'axe de la lampe sur des plans horizontaux, à différentes distances est indiqué dans le graphique n° 2. La connaissance de cette répartition est très importante pour l'étude des écartements et des temps de passage sous les lampes. Les mesures thermiques ont été faites avec des microthermocouples permettant avec une sensibilité de 1/10° de degré de suivre les courbes de température dans plusieurs points du fruit, du grain ou de l'insecte soumis aux radiations infra-rouges.

Les chataignes étaient soit contaminées artificiellement par introduction de larves dans des loges forées mécaniquement, soit prises au hasard; après le passage dans l'appareil, on ouvrait la chataigne aux fins d'examen des larves et chenilles; enfin des observations ont été faites sur des lots importants traités dans le cadre agricole, après épluchage des chataignes pour la confiserie.

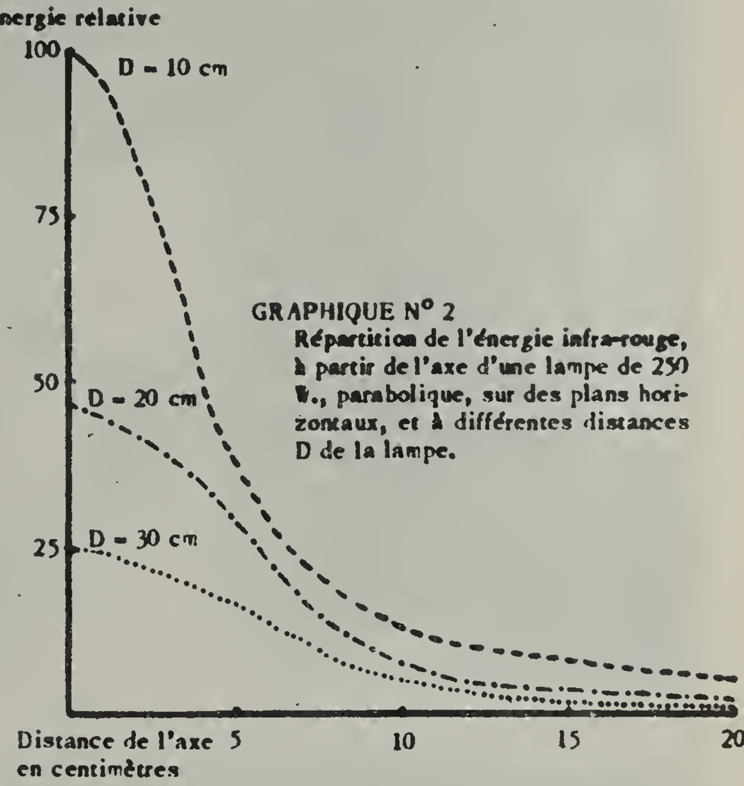
Description du four infra-rouge

L'appareil est en tôle d'aluminium, à double parois, calorifugées avec de la laine de verre. Le montage électrique est réalisé en fil de cuivre sous amiante. Le four comprend 2 parties:

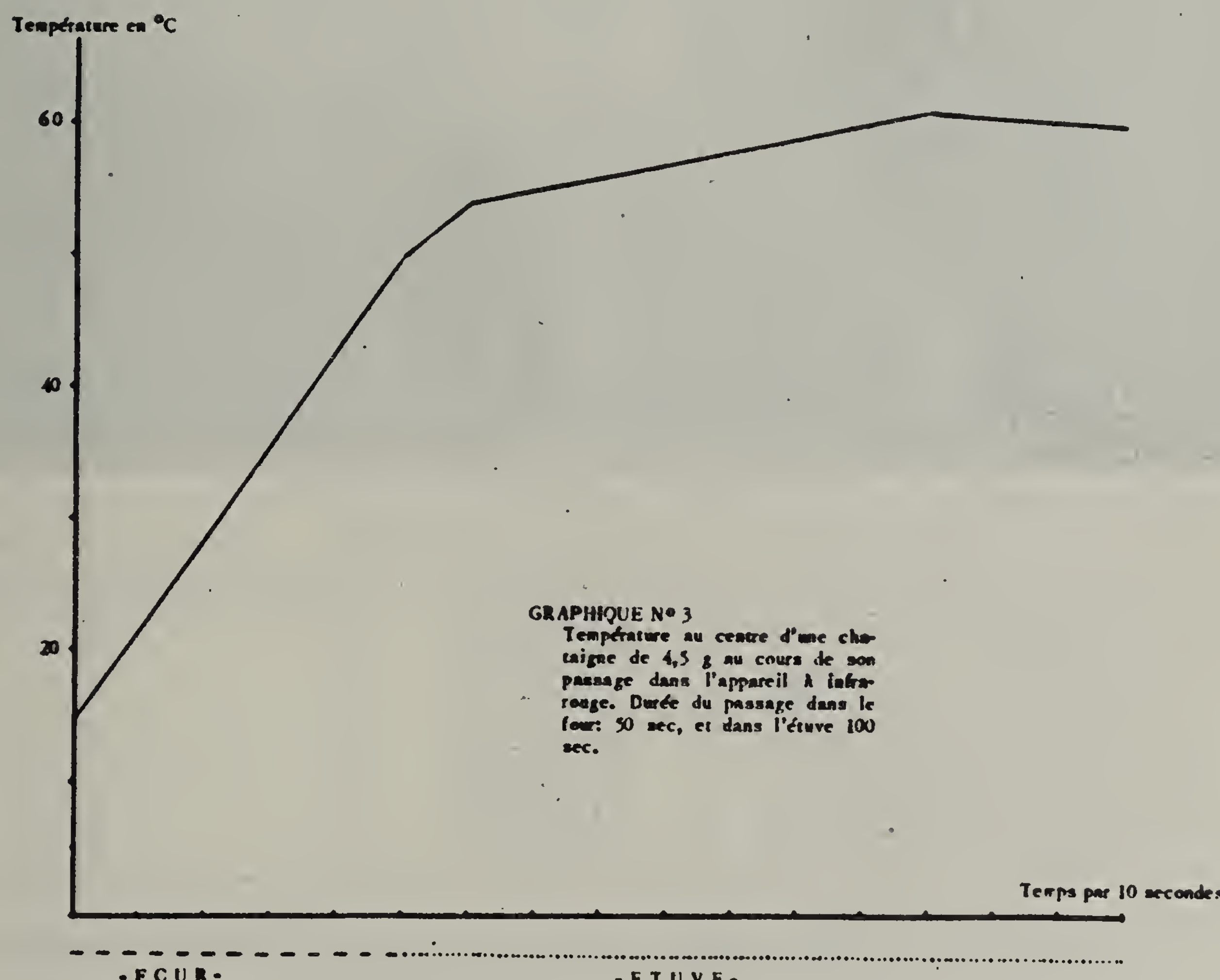
1°) *Le four proprement dit:* avec 2 lits de lampes de 250 watts paraboliques, 13 lampes à la partie supérieure, 12 à la partie inférieure, montées sur des axes dont la distance et la hauteur sont réglables; les dimensions du four sont de 80 x 50 cm, et sa hauteur 70 cm.



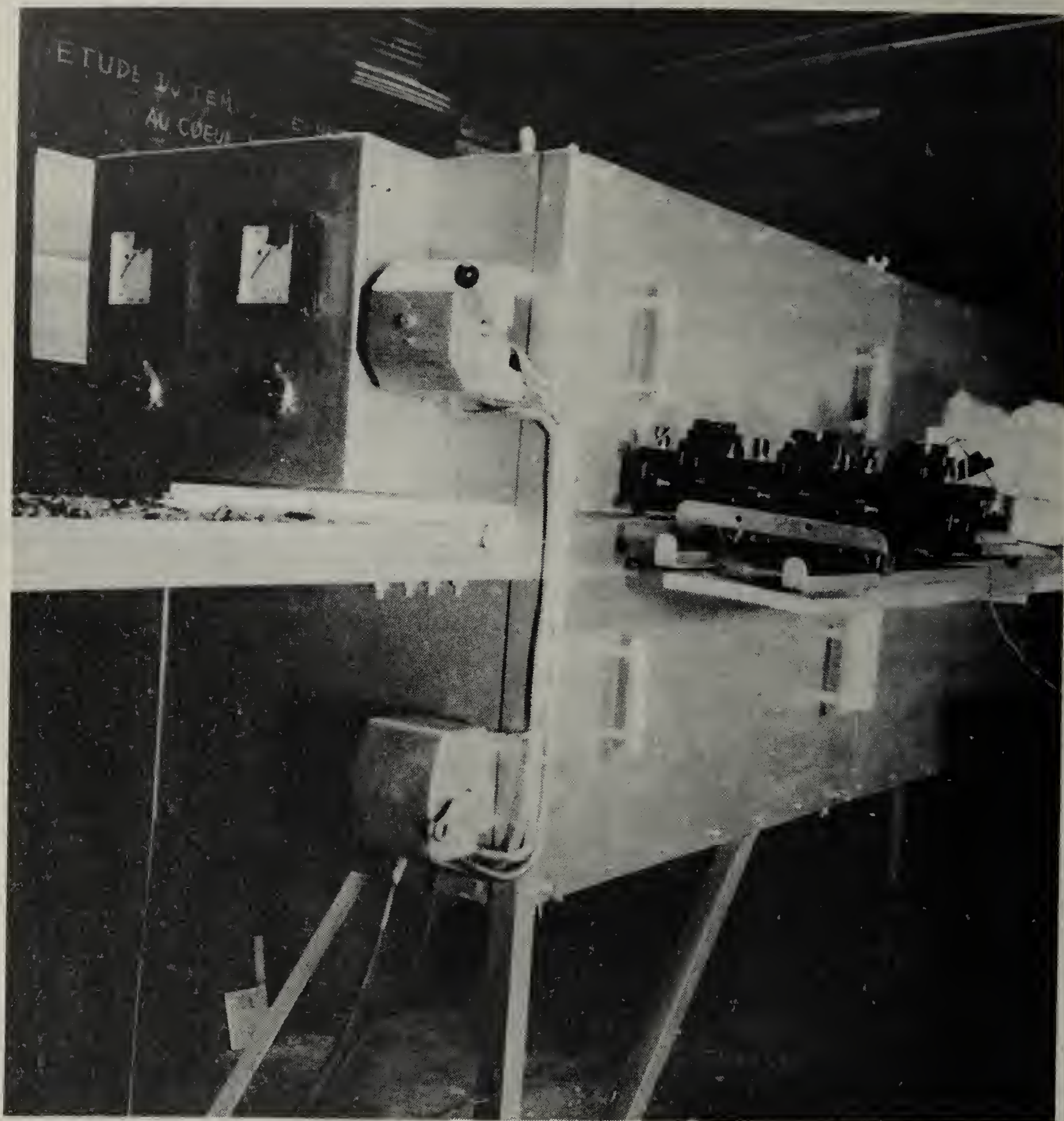
GRAPHIQUE N° 1
Prolongation de l'échauffement dans une chataigne après l'arrêt du rayonnement infra-rouge: ↑; 2 lampes de 250 W, distance de 12 cm, chataigne de 4 g. Température prise au centre de la chataigne.



GRAPHIQUE N° 2
Répartition de l'énergie infra-rouge, à partir de l'axe d'une lampe de 250 W., parabolique, sur des plans horizontaux, et à différentes distances D de la lampe.



GRAPHIQUE N° 3
Température au centre d'une chataigne de 4,5 g au cours de son passage dans l'appareil à infra-rouge. Durée du passage dans le four: 50 sec, et dans l'étuve 100 sec.



2°) *L'étuve:* dont la longueur est le double de celle du four et dont les parois sont calorifugées pour entretien de la température par convection.

L'alimentation de l'appareil en chataîgne est semi-automatique; les chataignes calibrées sont disposées en une seule couche sur des plateaux à maille large, et roulants; ils sont entrainés sur 2 rails par une chaine reliée à un moteur à vitesse variable, entre les deux lits de lampes.

Le contrôle thermique expérimental est réalisé par thermocouples montés sur un chariot se déplaçant parallèlement et à la même vitesse que le plateau garni de chataignes. Une fente d'1 cm sur toute la longueur du four permet aux cables de suivre le plateau durant tout le trajet (Figure 1).

Temps de traitement des fruits

Le temps de passage des chataignes sous les lampes est fonction de nombreux paramètres: taille, teneur en eau des fruits, écartement entre les lits de lampes, densité de lampes au mètre carré. Le contrôle de la température interne au coeur de la chataigne est assuré par thermocouples.

Il faut obtenir une courbe de température de 52 à 55° dans le fruit pendant un temps de 60 secondes, pour obtenir une léthalité de 100% des insectes logés; selon la grosseur des fruits, et leur fraîcheur, les temps de passage dans la partie four, sous les lampes, peuvent varier de 45 à 90 secondes dans les conditions où nous avons opéré (graphique n° 3); ce temps peut être accéléré ou racourci en diminuant la distance entre les lits de lampes, et en augmentant le nombre de lampes.

Pertes de poids et qualité des fruits après le traitement

La perte de poids des fruits due au procédé est pratiquement insignifiante; son étude a été entreprise sur des chataignes italiennes, qualité AA, 60/65 kilogs, en janvier, sur des lots de 30 kilogs; les conditions électriques étaient les suivantes: ampérage 27,5 Amp., Tension 205 volts, distance entre les lits de lampes: 4 et 7 cm. Les résultats sont consignés dans le tableau ci-dessous:

Temps de passage sous les lampes en sec.	Poids du lot avant le traitement	Poids après le traitement	Perte d'eau en Kg	en %
48	29.750 Kg	29.725 Kg	0.025	0.0835
56	29.750 Kg	29.700 Kg	0.050	0.16
67	29.800 Kg	29.700 Kg	0.100	0.335
83	29.700 Kg	29.550 Kg	0.160	0.505
102	30.000 Kg	29.750 Kg	0.250	0.833

Les qualitées organoleptiques des fruits traités dans les conditions précitées et avec les temps inférieurs à 102 secondes restaient intactes tant pour la confiserie que pour la confiturerie. Après 102 secondes sous les lampes, on a noté que les fruits prennent un gout de fumée; (ce temps est supérieur à celui qui est nécessaire pour obtenir la mort des insectes). Sur les chataignes

très fraiches, le rayonnement infra-rouge provoque un léger ternissement de l'épicarpe du fruit. Outre que cet inconvénient puisse être compensé par lustrage après le traitement, des essais ultérieurs ont montré qu'il pouvait être facilement évité en injectant de l'air par un ventilateur au niveau des fruits, de manière à abaisser la température de surface, qui normalement atteint environ 160°C; et ceci sans modifier la courbe d'élévation de température dans la chataigne qui absorbe sélectivement la rayonnement direct.

Conclusion

Le chauffage par rayonnement infra-rouge permet de traiter rapidement et efficacement les chataignes contre leurs insectes parasites, sans que leurs qualités gustatives et leur conservation soient altérées.

L'intérêt essentiel de cette technique réside dans le fait, que le traitement est polyvalent et permet de détruire conjointement les champignons parasites [2].

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DIE BEKÄMPFUNG DER VORRATSSCHÄDLINGE DURCH HITZE, INSBESONDERE HOCHFREQUENZWÄRME

von

Friedrich ZACHER
Berlin-Steglitz, Deutschland

Die für Insekten absolut tödlichen Temperaturen weisen grosse Unterschiede auf und zwar sowohl von Art zu Art wie auch innerhalb einer Art für die verschiedenen Stadien und schliesslich auch individuell in Abhängigkeit von dem jeweiligen physiologischen Zustand. Für die Vorratsschädlinge variieren sie aber doch – mit wenigen Ausnahmen – nicht allzusehr und zwar liegen sie nicht allzuhoch über der Vorzugstemperatur, etwa 10 - 18° C über dieser. Für die meisten Arten sind Temperaturen von + 47 - 50° C in allen Entwicklungsstadien tödlich. Grössere Widerstandfähigkeit haben u.a.

Rhizopertha dominica, tödliche Temperatur +62,8° - 71°(V.T. 39,5°) sowie
Trogoderma granarium, tödliche Temperatur +58° , 5 Minuten
+62° , 3 Minuten
+97° , ½ Minute.

Im allgemeinen vertragen Tiere aus subtropischen ariden Gebieten und aus den Tropen höhere Temperaturen, ebenso Tiere aus heissen Quellen. Einige Käfer und Zuckmückenlarven leben z.B. ständig in Wasser mit +46 bis 50° C.

Beim Kornkäfer erzielte ich 100% Abtötung aller Stadien in einzelnen Fällen mit erhitzter Luft bei +47,2° C in 1½ Stunden, in anderen erst bei 52,5-53° und 2¾ bis 3½ Stunden. Die Wärmelähmung begann bei +43° C. Erwärmung von Getreide innerhalb 6 Stunden auf +44,9° führte zur Abtötung der ausserhalb des Getreides vorhandenen Käfer. Doch schlüpften noch gesunde Käfer aus den Körnern, wogegen die in den Körnern enthaltenen Larven und Puppen nicht mehr zur Entwicklung kamen, sondern abstarben. Nach derselben Behandlung befallenen Getreides mit +47,2° waren alle Tiere tot. Für *Plodia interpunctella* wird von LOVETT (1921) die Abtötungstemperatur für alle Stadien mit 51,7-54,4° C angegeben. In meinen Versuchen begann die Wärmestarre bei +41°-44°. Aber selbst auf +52,5° erhitzte Tiere erwachten wieder und legten Eier, die allerdings nicht entwicklungsfähig waren. Im Brutschrank bei +28° gezogene Tiere waren widerstandsfähiger als solche aus Zimmerzuchten bei +18-20°. Falter, die vor der Behandlung Wasser getrunken hatten, überstanden ohne volle Starre, +44°, während ungefütterte aus der gleichen Zucht und nach der gleichen Behandlung tot waren. Langsame Erwärmung auf +53° C genügte bei einer Kultur in Haselnuss, um alle Stadien abzutöten, bei Sojamehl hingegen nicht. Bei der Mehlmotte, *Ephestia kuhniella,* stellte MANSBRIDGE folgendes fest: 100% Abtötung aller Stadien erfolgt bei +45-47° C und 70% rel. Luftfeuchtigkeit und zwar 1 Tag alte Eier in 4, 3 Tage alte Eier in ½, junge Raupen in ¾, erwachsene Raupen in

2, Vorpuppen in 1¼, Puppen in 2½, Imagines in ¾ Stunden. Ich erhielt beginnende Wärmelähmung bei +29,5° C, permanente Lähmung bei +42,5°, Tod bei 43° C. Dagegen überlebte *E.cautella* die erste Erhitzung auf +45/46° C ohne Schädigung, während eine zweite Erhitzung auf den gleichen Grad alle Tiere tötete. Beim Bohnenkäfer, *Acanthoscelides obtectus*, verhalten sich die einzelnen Stadien nach BACK und DUKETT folgendermassen:
Eier tot nach 10 Min. bei + 52° C, junge Larven, erwachsene Larven, Puppen, Imago tot nach resp. 20, 20, 25 und 4 Min. bei + 55° C.

Wie bereits bei *Ephestia* gezeigt wurde, können nahe verwandte Formen sehr verschieden reagieren, so z.B.: *Tribolium castaneum:* Imago tot nach resp. 26 und 4.9 Min. bei resp. + 48° und + 50° C; *Tr. confusum:* Imago tot nach resp. 70 und 10 Min. bei resp. + 50° und + 52° C.

Aus allen Untersuchungen kann man schliessen, dass eine Temperatur von etwa +55° C ausreichen muss, um alle bei uns in Speichern, Mühlen und Fabriken regulär vorkommenden Schädlinge in kurzer Zeit, d.h. wenigen Minuten, abzutöten, wenn diese Temperatur die Insekten effektiv erreicht.

Hierauf gründen sich die mannigfachen Methoden der Hitzeanwendung im Vorratsschutz. Es ist das eine der ersten Massnahmen überhaupt, die man angewandt hat. Schon im 18. Jahrhundert wurde Erhitzung des Getreides in Öfen als Mittel gegen die Getreidemotte empfohlen. Am wichtigsten für die Mühlenindustrie ist die amerikanische, auf Arbeiten von DEAN und COTTON basierende Methode der „Überheizung". Auch in Deutschland hat man schon vor etwa 30 Jahren in der Bienertschen Hofmühle in Dresden die Überheizung angewandt, sie aber später aus wirtschaftlichen Gründen zu Gunsten der Blausäuredurchgasung aufgegeben. In U.S.A. heizt man die Mühlen innerhalb von 20-24 Stunden auf +47,7-54° C, wobei die hohe Temperatur mindestens für 10 Stunden aufrecht erhalten und die Luftfeuchtigkeit mindestens 50% betragen muss. Jedoch ist der Erfolg in gewissem Masse von der Witterung, besonders vom Wind abhängig. Gleichfalls in U.S.A. benutzt man Hitze auch für Sterilisierung grösserer Mahlprodukte *vor* der Verpackung, wobei für Produkte zur Gebäck- und Teigwarenherstellung bis zu +82° C, sonst auch noch höhere Hitze angewandt wird. Die Temperatur im Substrat kann innerhalb von 5 bis 6 Minuten auf +71° gebracht werden.

Ich will ferner die Raumerhitzung durch transportable Heizapparate erwähnen (Thermodes in Deutschland, Thedeco in Schweden). Vielfach und mit bestem Erfolg sind Trockenapparate und Heissluftdesinfektionsapparate mit und ohne Vakuum in Gebrauch, für Getreide, für Trockenobst, Trockengemüse usw. Nach MATHLEIN kann man in diesem Getreide ohne Vakuum mit 47-48° C, was den anfangs von mir gemachten Angaben entspricht, mit Vakuum in 1 Stunde mit 44° oder in 2½ Stunden mit 40° C entwesen. Nach meinen Erfahrungen in der Gemüsetrocknung wird zwar das Gut durch Dörren mit 60-85° je nach der Art des Gemüses sicher entwest, aber wenn es abkühlt, wird es durch Wärme- und Geruchsreize in höchstem Grade für die Motten (*Plodia, Ephestia elutella*) anlockend, und deshalb von neuem befallen. Auch für die Bekämpfung von Holzschädlingen kann Hitze mit Vorteil angewandt werden,

so z.B. in den Deuba-Verfahren gegen den Hausbock und in Darren (mit 65-70° C) gegen Splintholzkäfer.

In vielen Fällen ist es für die Anwendung der Hitzebehandlung hinderlich, dass die von den Vorratsschädlingen befallenen Waren in der Regel sehr schlechte Wärmeleiter sind. Infolgedessen muss entweder ein sehr erhebliches Wärmegefälle, durch sehr hohe Ausgangstemperaturen erzeugt oder die Zeit der Anwendung sehr ausgedehnt werden. Beides kann die Wirtschaftlichkeit in Frage stellen. Nur als Beispiel sei Mehl angeführt: das Innere einer 10 cm dicken Mehlschicht in einem +51° C warmen Wasserbad erreicht diese Temperatur erst in 4½ Stunden und gesacktes Mehl muss in einem auf +54-60° C erhitztem Raum wenigstens 4 Tage stehen, damit die Temperatur durchdringt. BALZER (1942) sagt, für alle in lagerndem Reis vorkommenden Insekten sei Anwendung von +60° für 10 Minuten zwar tödlich, jedoch erwärme sich Reis so langsam, dass im Innern der Körner alle Insekten vorzüglich geschützt wären.

Hier bietet die Anwendung der Hochfrequenzerwärmung einen vorzüglichen Ausweg. Mit Hochfrequenz können auch empfindliche Nahrungsmittel ohne Schädigung schnell und gleichmässig erwärmt werden. Die Wärme wird nicht von aussen durch Leitung zugeführt, sondern durch Anlegen eines elektrischen Feldes im Innern des Gutes gleichmässig erzeugt. Behälter aus Glas, Porzellan, Holz, Kunststoff, Pappe, Papier nehmen wenig Energie auf und erwärmen sich daher kaum. Man kann also auch geschlossene Packungen mit Mehl, Gries, Haferflocken, Nährmitteln, Drogen, Tabakwaren usw. ohne Schädigung des Inhaltes und der Verpackung auf die zur Tötung der Schädlinge notwendige Temperatur erhitzen.

Für meine Versuche, die ich anfangs mit dem Institut für Ernährungs- und Verpflegungswissenschaft gemeinsam durchführte, verwandte ich zuerst einen Generator der Firma Telefunken mit 1 Kw Leistung und 15 m Wellenlänge, später mit Unterstützung von Siemens-Schuckert AG einen Generator mit 6 m Wellenlänge.

Die Temperatur, die notwendig ist um die Abtötung zu erzielen, ist nicht nur von der Art des Schädlings, sondern auch von dem sie umgebenden Medium abhängig. Im allgemeinen muss sie umso höher sein je sperriger das Gut ist. Bei Getreide steigt sie anscheinend mit sinkendem Hl-Gewicht.

Der Kornkäfer war restlos tot in Mehl bei 48-50° C, in Weizen bei 52° C, in Gerste bei 55° C.

Man braucht rund 1 Minute um das Getreide von 20° C auf 60° C zu erwärmen.

Für die Abtötung von Mehlmottenraupen in Weizenmehl waren +63° C und 3 Minuten bei der 15 m Welle, dagegen nur +39-46° C und 38 Sekunden bei der 6 m Welle erforderlich. Die Kornmotte, *Tinea granella*, war in allen Stadien tot bei 15 m in Saxa-Bohnen bei +55° C, in sog. „Keimdiät" (Nährmittel aus Getreidekeimen) bei +60° C. Auch beim Reiskäfer (der etwas resistenter ist als der Kornkäfer) zeigt sich die Überlegenheit der kurzen Welle sehr deutlich. Während bei 15 m einige Käfer +53-59° C für 4 Minuten überstan-

den, waren sie bei 6 m bereits durch Einwirkung von +45°-52,8° C in 1,2 Minuten tot. Das Gleiche gilt für Speisebohnenkäfer: alle Stadien 100% tot mit 6 m bei +47-57° in 58 Sekunden, mit 15 m erst bei +61°.

Ein sehr wichtiger Befund ergab sich beim Reiskäfer: die mit 6 m getöteten Tiere hatten nur noch 14,3% Wassergehalt, die unbehandelten Kontrolltiere aber 45,8%. Sie hatten also in der kurzen Zeit von 1,2 Minuten 31,2% ihres Körperwassers verloren.

Bei verschiedenen Versuchen mit Lebensmittelpackungen zeigte es sich, dass die Tiere, die im Substrat sassen, zwar getötet wurden. Gelang es ihnen aber in den Luftraum zu entweichen, so entgingen sie der Vernichtung. Das war besonders auch bei Mehlmilben in Kleie der Fall. Wenn wir den Luftraum im Gefäss mit Watte abschlossen, die bis zur Oberfläche der Kleie reichte, so waren alle Milben bei 6 m mit +35-45,5° C in 30 Sekunden tot, ohne Watte dagegen überstanden sie +73-74° C für 43 Sekunden. Das spielt für die Praxis der Lebensmittelindustrie, die diese neue physikalische Methode der Schädlingsvernichtung sehr begrüsste, eine erhebliche Rolle. Man hat sich dadurch geholfen, dass man die Packungen umdrehte, d.h. auf den Kopf stellte und ein zweites Mal dem Feld aussetzte. Dadurch wird natürlich die Behandlung etwas teurer.

Wie ich oben ausführte werden erwachsene Mehlmottenraupen durch +45-47° C in erhitzter Luft in 2 Stunden abgetötet. Durch Hochfrequenzwärme sterben sie bei 6 m Wellenlänge und +39-46° C bereits in 58 Sekunden. Der Versuch mit den Reiskäfern beweist, dass die Tiere bei Anwendung der kurzen Welle in kürzester Zeit einen erheblichen Teil ihres Wassers verlieren. WIGGLESWORTH erklärte die Unterschiede in der tödlichen Temperatur bei verschiedenen Insektenarten durch den verschiedenen Schmelzpunkt des Wachses der Epicuticula. Durch die Verflüssigung soll der Verdunstungsschutz aufgehoben werden. Für die Erklärung des Hitzetodes gibt es noch verschiedene andere Theorien: Lösung und Verflüssigung des Fettinhalts der Zellen, Koagulation von Eiweiss und Proteinen, Bildung und verhinderte Ausscheidung giftiger Stoffwechselprodukte, u.U. Verzögerung der enzymatischen Adsorption usw. Die Schnelligkeit des Wasserverlustes dürfte, ebenso wie bei den oberflächenaktiven Pulvern eine wesentliche Rolle spielen. Die vergleichsweise sehr viel raschere und intensivere Wirkung der kurzen Welle könnte damit erklärt werden, dass die in das Tier eindringt und direkt in diesem die tödliche Wärme erzeugt, während bei der langen Welle die Erhitzung des Substrates durch Wärmeleitung die Abtötung verursacht. Auf jeden Fall ist in der Hochfrequenzwärme ein physikalisches Mittel vorhanden, dass bei weiterer Erforschung der Zusammenhänge Aussicht hat, in der Schädlingsbekämpfung eine bedeutende Rolle zu spielen.

ÜBER DIE VERLÄNGERUNG DER WIRKSAMKEITSDAUER VON GAMMA-HEXACHLORCYCLOHEXAN SPEZIELL BEI VERWENDUNG ALS AEROSOL ZUR BEKÄMPFUNG VON VORRATSSCHÄDLINGEN[1]

von

M. SY

Seelze bei Hannover, Deutschland

Von den neuen synthetischen Insektiziden werden in Deutschland im wesentlichen folgende drei Gruppen verwendet: DDT, Hexachlorcyclohexan und Phosphorsäureester. Alle 3 haben ihre besonderen Vor- und Nachteile und damit nebeneinander ihre Existenzberechtigung.

Eine wesentliche Eigenschaft, in der sie sich unterscheiden, bildet die Wirksamkeitsdauer, bedingt durch unterschiedliche Dampfspannung. Geringste Dampfspannung und längste Wirksamkeitsdauer hat DDT, höchste Dampfspannung und geringste Wirksamkeitsdauer haben die Phosphorsäureester. Hexachlorcyclohexan steht in der Mitte. Wo es auf einen insektiziden Dauerschutz an Pflanzen oder in Räumen ankommt, scheint demnach das DDT am besten geeignet zu sein.

Gegenüber dem DDT weisen jedoch die anderen Insektizide eine Reihe von Vorteilen auf, die den Wunsch nahelegen, den Nachteil der geringeren Wirksamkeitsdauer durch geeignete Massnahmen auszugleichen. Wir wollen uns, gemäss dem Thema, hier auf die Verwendung als Aerosol beschränken und nur die Anwendung in geschlossenen Räumen ins Auge fassen. Auch soll lediglich vom Hexachlorcyclohexan (in folgenden kurz HCH genannt) gesprochen werden, da die Phosphorsäureester infolge ihrer hohen Giftigkeit für Mensch und Warmblüter nur unter Beachtung besonderer Vorsichtmassnahmen in geschlossenen Räumen anwendbar sind.

HCH hat hier erstens den Vorteil der Wirksamkeit gegenüber einigen Insektenarten, die auf DDT nicht so gut ansprechen, wie z.B. Speckkäfer, Zecken, Hühnermilben. Einen zweiten Vorteil bildet die vielfach höhere Wirksamkeit, so dass man bedeutend geringere Wirkstoffmengen benötigt, vor allem bei Verwendung der reinen Gamma-Isomere. Ein dritter, technischer Vorteil ist in den für HCH geeigneten Lösungsmitteln gegeben. Nicht vergessen sei auch die höhere Gefährlichkeit des DDT für den Menschen.

Nachteilig ist also im wesentlichen nur die schnellere Verdampfung. Es wurde daher zur Aufgabe gesetzt, ein Vernebelungsmittel mit Gamma-HCH als Wirkstoff zu schaffen, dessen Niederschlag auf den Raumflächen eine möglichst lange Wirksamkeitsdauer behält.

Als Gerät für die Vernebelung diente im Laborversuch der „Parexator I" (Abb. 1 u. 2). Das Prinzip ist die Erzeugung eines Dampfstromes, der die Verneblungsflüssigkeit ansaugt und in einer Düse vernebelt. Für Versuche an natürlichen Befallsobjekten diente auch der „Parexator II", bei dem ein

1) Cliché's provided by the author.

Luftstrom nach dem Staubsaugerprinzip erzeugt wird. Die Nebelerzeugung erfolgt hier durch ein im Luftstrom schnell rotierendes Wirbelrad. (Abb. 3, 4)

Die Testung erfolgte an Stubenfliegen nach folgendem Verfahren: In einem Spezialraum wurde unter stets gleichen Bedingungen Fliesspapier ausgelegt, der Raum vernebelt und dem Aerosol eine halbe Stunde Zeit zum Absetzen gegeben. Das benebelte Fliesspapier wurde dann in einem grösseren Raum bei Zimmertemperatur frei aufgehängt. Nach 24 Stunden erfolgte die erste Testung. Das Fliesspapier wurde hierfür auf einer Tischfläche ausgelegt und mit einer Glasglocke bedeckt, in die ein gleichartig behandelter Fliesspapierstreifen eingelegt war, wie es die Abb. 5 zeigt. Durch die obere Öffnung wurden zwischen 70 und 100 Fliegen im Alter von 4 Tagen eingebracht. Alle Testungen liefen bei konstanter Temperatur von 21° C.

Als Wirkungskriterium diente das Stadium der Intoxikation, bei welchem die Fliegen mit Krämpfen am Boden liegen oder kreiseln und flug- und laufunfähig sind, also der Knockdown-Effekt. Alle 5 Minuten erfolgte eine Auszählung, insgesamt über 1½ Stunden. Bis zu 8 Testungen liefen in einer Versuchsparallel (Abb. 6).

Den Verlauf der prozentualen Knockdown-Zunahme zeigen folgende Beispiele in graphischer Darstellung (Tab. 1). Die Kurven haben ihren steilsten

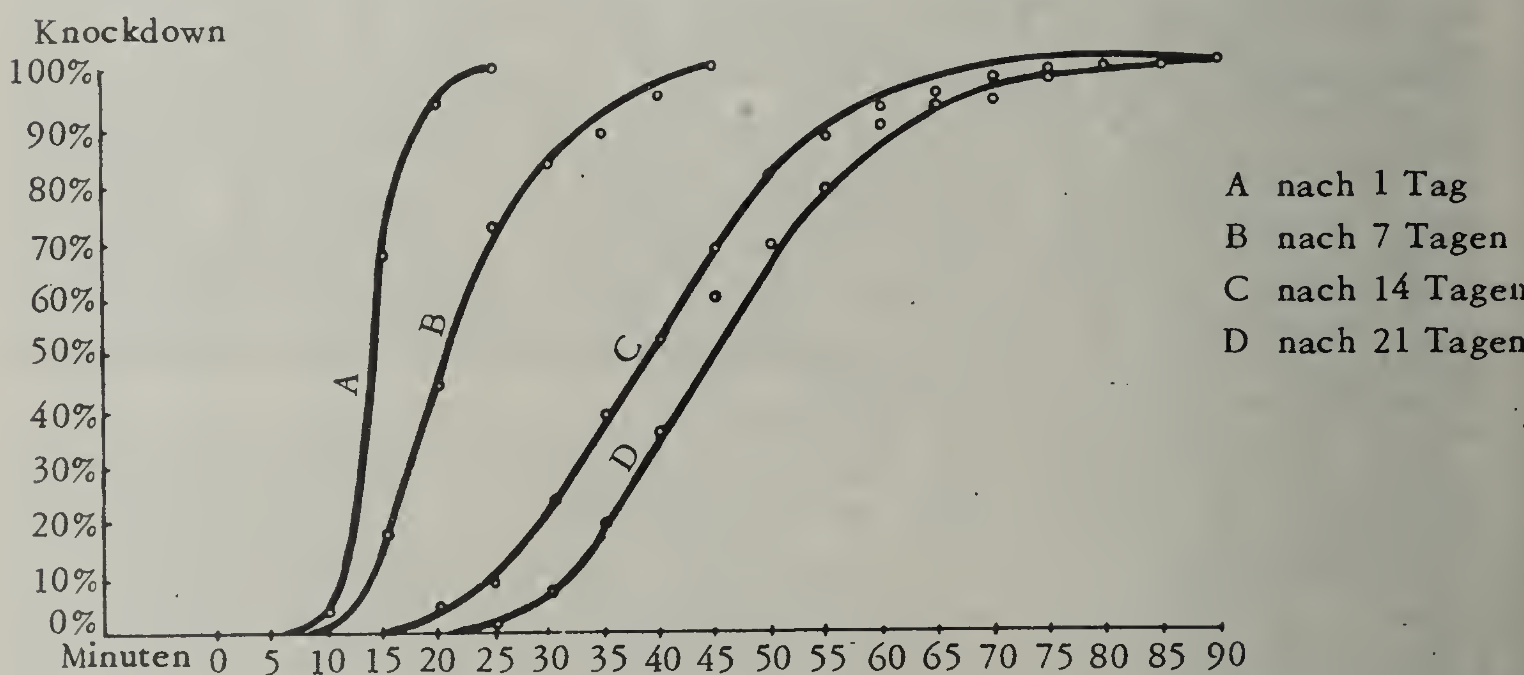

Tabelle 1 — Zunahme des prozentualen Knockdown-Effektes in Abhängigkeit von der Einwirkungszeit. — Nebelniederschlag von Parex WW, Testung nach verschiedener Anzahl von Tagen an Fliegen.

Abschnitt im Bereich des 50%igen Knockdowns. Unterschiede in der Wirksamkeit verschiedener Mittel zeichnen sich also an dieser Stelle am deutlichsten ab. In den folgenden Darstellungen werden darum stets allein die Zeitwerte für den 50%igen Knockdown dargestellt.

Betrachten wir zunächst den Gegensatz zwischen reinem DDT und reinem Gamma (Tab. 2). Bei der Kontrolle nach 1 Tag haben DDT und Gamma etwa die gleiche Wirkungsgeschwindigkeit. Damit ist die eigentliche Initialtoxizität nicht erfasst, denn eine Wirksamkeitsdauer über 24 Stunden bedeutet schon eine Dauerwirkung, wenn wir uns unserer früheren Kontaktinsektizide

Abb. 1 — Parexator I in Betrieb

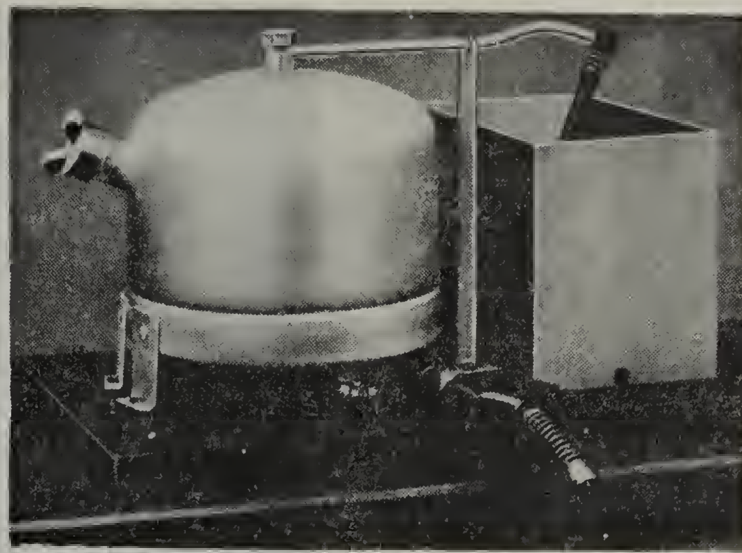

Abb. 2 — Parexator I ohne Gehäuse

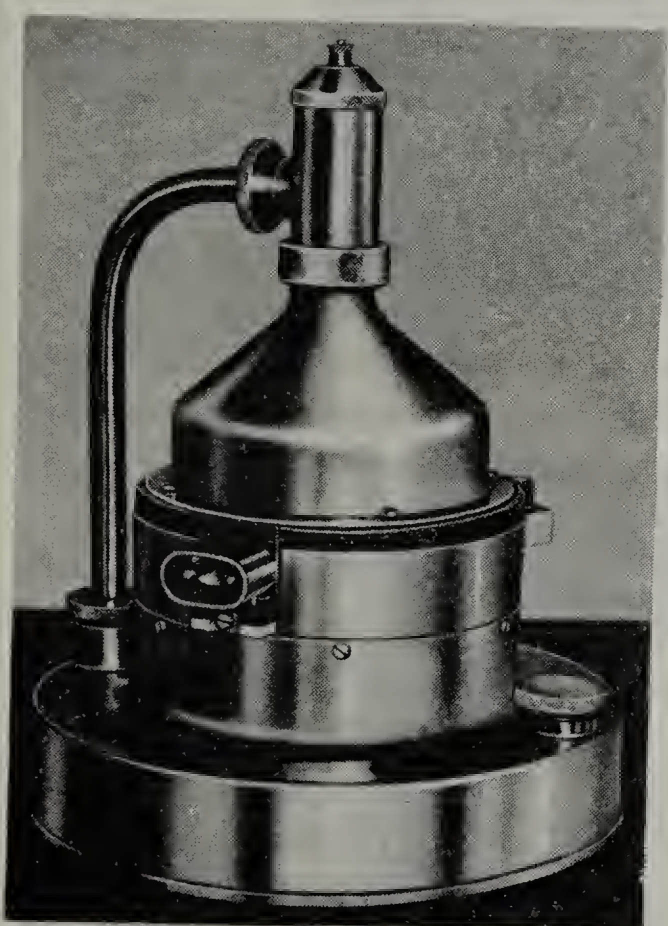

Abb. 3 — Parexator II, Gesamtansicht

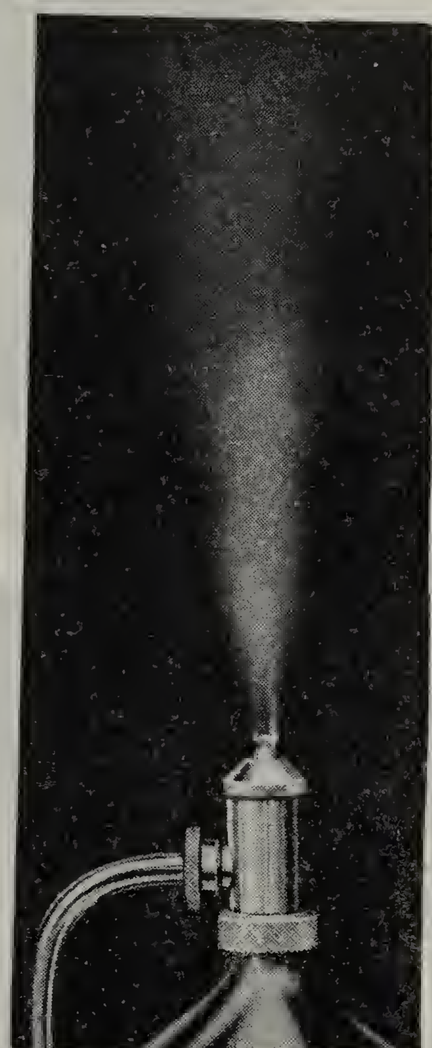

Abb. 4 — Parexator II in Betrieb. Vom Gerät nur der obere Teil sichtbar.

Abb. 5 – Glasglocke zur Testung von behandeltem Fliesspapier an Fliegen.

Abb. 6 – Versuchsreihe mit mehreren Testglocken nebeneinander.

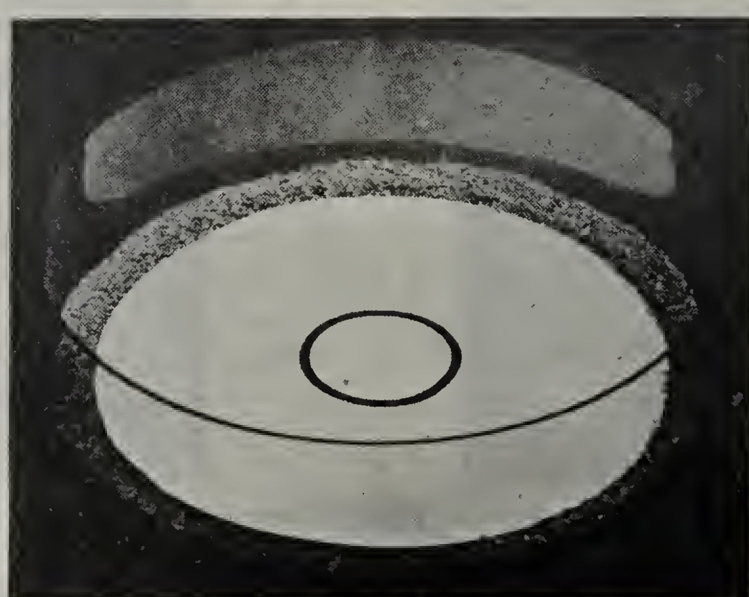

Abb. 7 – Versuchsanordnung für Prüfung der insektiziden Wirkung auf Eiraupen der Mehlmotte.

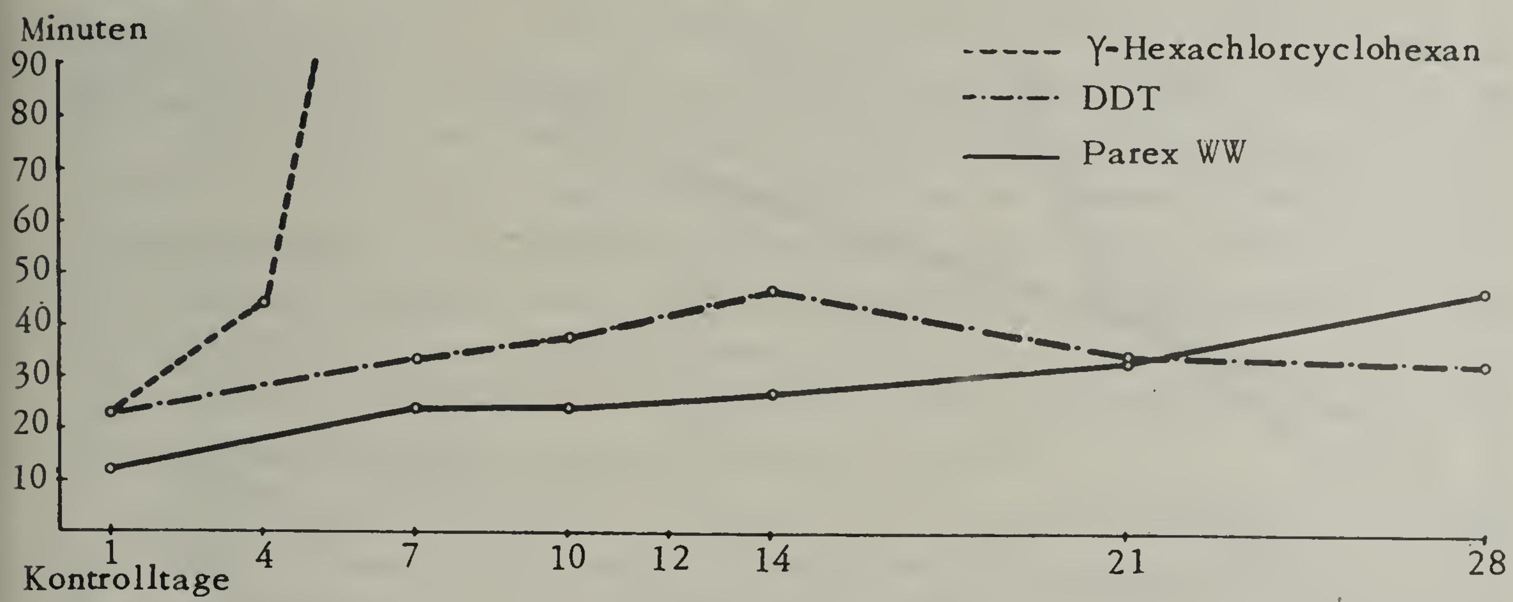

Tabelle 2 – Dauerwirkung von reinem gamma-HCH, DDT und Parex WW, Wirkstoff stets 3% Gew./Vol. – Dargestellt der 50%ige Knockdown-Effekt.

aus Pflanzenextrakten wie Nikotin und Pyrethrum entsinnen. Nach 4 Tagen fällt Gamma schon stark gegen DDT ab und erreicht nach 7 Tagen nicht mehr 50%igen Knockdown.

Es wurden nun zahlreiche Stoffe geprüft, deren Zusatz theoretisch eine Verlängerung der Wirksamkeit des Niederschlages versprach. Viele Stoffe führten statt zu einer Verlängerung zu einer Verminderung der Wirksamkeitsdauer, vermutlich auch zu einer Herabsetzung schon der Initialtoxizität. Diese Stoffe kapseln den Wirkstoff offenbar so gründlich ein, dass er an den Insekten nicht zur Wirkung kommen kann. Einige Stoffe verlängerten die Wirksamkeitsdauer immerhin mässig.

Schliesslich fand sich ein Zusatzstoff, der die Wirksamkeitsdauer in überraschend starkem Masse verlängert (nach Tab. 2). Die Tabelle zeigt ihn im Vergleich zu unvermischtem Gamma und DDT, und man sieht, dass nun dieses Gamma-Gemisch in der Kontrollzeit von 24 Tagen und unter den geschilderten Versuchsbedingungen dem DDT in der Beständigkeit praktisch gleichwertig ist. Das Präparat erhielt den Namen „Parex WW", um es von dem früheren „Parex" auf Pyrethrumbasis zu unterscheiden.

Von anderer Seite ist versucht worden, die Verlängerung der Wirksamkeitsdauer durch den auch sonst in der Schädlingsbekämpfung oft geübten Zusatz eines Öles zu erzielen. Nach Vernebelung dieses Mittels hinterbleibt auf allen glatten Flächen ein glänzender Film. Linoleum sieht wie frisch geölt aus. Das Mittel wurde nach Vorschrift zu 6 ccm/cbm vernebelt, Parex WW nur zu 2.5 ccm/cbm. Ausserdem enthält es gegenüber Parex WW eine höhere Wirkstoffmenge, ist also auf die Raumeinheit bezogen um ein Vielfaches höher dosiert. Es ist darum nicht verwunderlich, dass in der Testung nach 1 Tag die Wirkung schneller eintritt als bei Parex WW. (Tab. 3).

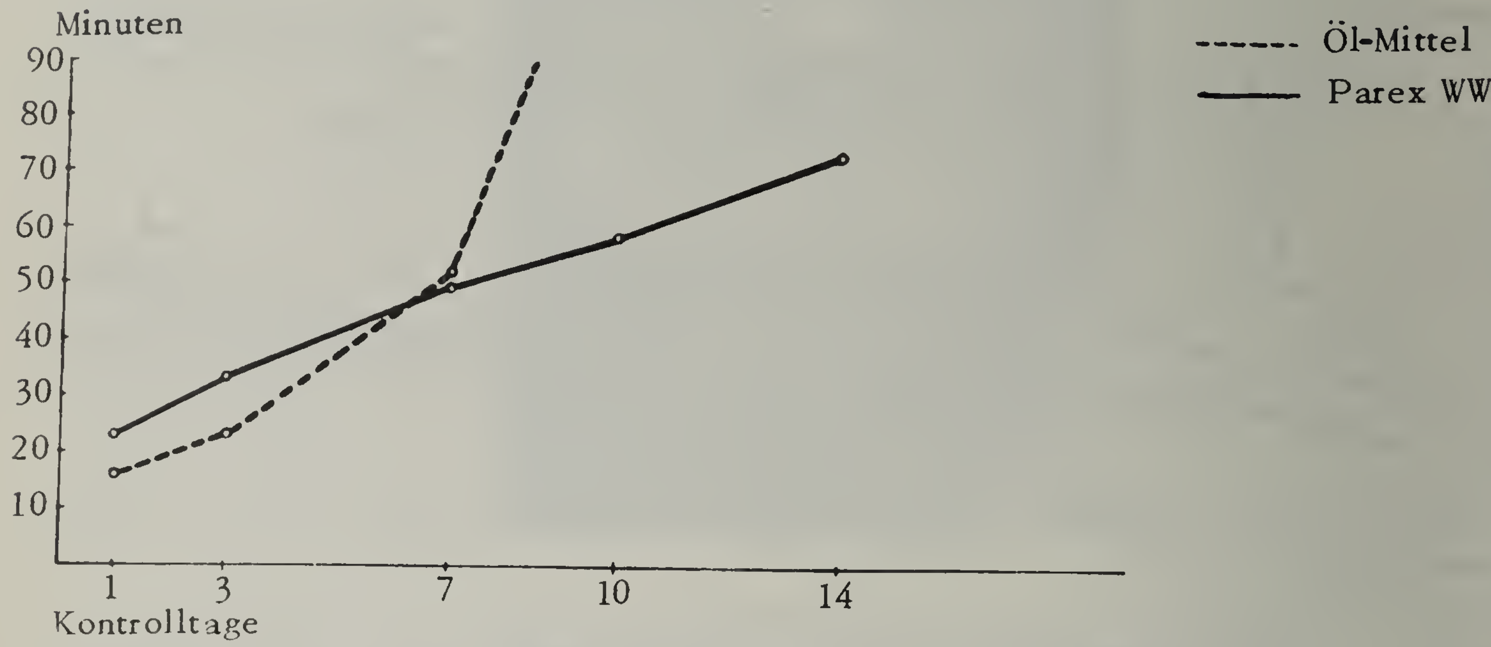

Tabelle 3 – Dauerwirkung eines Verneblungsmittels mit höherem Gehalt an gamma-HCH und Öl 6 ccm/cbm, im Vergleich zu Parex WW 2.5 ccm/cbm. Dargestellt der 50%ige Knockdown-Effekt.

Auch nach 3 Tagen besteht eine Überlegenheit. Nach 7 Tagen aber ist schon Parex WW leicht überlegen. Nach 10 Tagen erreicht das ölhaltige Mittel trotz der viel höheren Gamma-Menge innerhalb von 90 Minuten nicht mehr 50%igen Knockdown. Dieser Vergleich zeigt erstens, dass die Erhöhung der Gamma-Menge je Raumeinheit die Dauerwirkung nur sehr wenig zu verlängern vermag, und zweitens, dass die durch Ölzusatz zu erzielende Verlängerung der Wirksamkeitsdauer keineswegs maximal ist sondern von anderen Stoffen, hier festen, bedeutend übertroffen werden kann.

Der im Parex WW gewählte Zusatz zum HCH in Verbindung mit einem leicht flüchtigen Lösungsmittel scheint auch insofern vorteilhaft zu sein, als sich ein Teil der Aerosoltröpfchen schon vor dem Absetzen infolge rascher Verdunstung des Lösungsmittels in der Luft in feste Partikel verwandelt. Flüssige Partikel können nach dem Absetzen von den Flächen aufgesaugt werden, wobei ein Teil des Wirkstoffes von der Oberfläche verschwindet und wirkungslos wird. Bereits vor dem Absetzen fest abgeschiedene Partikel verbleiben dagegen mit Sicherheit auf den Oberflächen und können verlustfrei ihre Wirksamkeit entfalten.

Die bisher geschilderten Ergebnisse wurden im Labor an einer Insektenart gewonnen und können uns lediglich über die relative Dauerwirkung unterrichten. Die Bestätigung an anderen Arten erbrachten Versuche von Dr REICHMUTH, Celle. In seinen Versuchen hielt die Dauerwirkung gegen Schaben sogar noch länger als gegen Fliegen an. Ebenso günstig waren die Ergebnisse an Kornkäfern. Gegen Speckkäfer und Kleidermottenlarven hielt die Wirkung nicht so lange an, brachte aber noch in der Testung nach mehreren Tagen vollen Abtötungserfolg.

Auch diese Feststellungen wurden zunächst im Labor getroffen. Zur Be-

stätigung unter praktischen Verhältnissen wurden eine Reihe von Schabenbekämpfungen in Bäckereien, Wohn- und Vorratsräumen vorgenommen. Die Schabenbekämpfung ist in den Sommermonaten besonders schwierig, weil die Tiere weitgehend unabhängig von künstlichen Wärmequellen sind und sich weit vom eigentlichen Befallsherd entfernen können. Eine Behandlung der Räume mit Mitteln ohne Dauerwirkung hat darum im Sommer besonders geringe Erfolgsaussichten. Hier zeigte die Vernebelung von Parex WW beste Erfolge, denn noch nach Wochen fanden sich immer wieder neu vergiftete und im Krämpfen liegende Tiere, ein sicherer Beweis dafür, dass es keine bei der Reinigung der Räume übersehenen Kadaver vom Behandlungstage her sein konnten, sondern neuerdings zugewanderte sein müssten.

Ausführlicher sei noch die Wirkung auf Mehlmotten behandelt. Es zeigte sich nämlich, dass die Wirkung der Raumvernebelung gegen Falter nur wenige Tage anhält und die gegen verpuppungsreife Raupen, welche auf ihrer Wanderung zu Verspinnungsplätzen besonders augenfällig sind, überhaupt unbefriedigend ist. Es wurde aber vermutet, dass die jüngsten, gerade aus den Eiern kommenden Raupen wesentlich anfälliger sind. Für die Befallsverminderung kommt es bekanntlich meist nur darauf an, den Lebenszyklus des Schädlings an einer Stelle zu unterbrechen. Wenn das in genügendem Prozentsatz gelingt, muss der Befall nach entsprechender Zeit aufhören.

Für die Versuche wurde folgende Methode gewählt (Abb. 7): Runde Fliesspapierblätter von 18 cm Durchmesser wurden in der Mitte durch ein fest aufliegendes Glasgefäss von 4,5 cm Durchmesser abgedeckt. Diese Papiere wurden in der vorher beschriebenen Weise mit einem Nebelniederschlag versehen, wobei der innere Kreis von 4,5 cm Durchmesser giftfrei blieb. Dann wurden die Papiere für verschieden lange Zeit in einem grösseren Raum bei Zimmertemp. frei aufgehängt. Nach einer bestimmten Zahl von Tagen kamen die Papiere in grosse Petrischalen. Der freie Rand zwischen Papier und Glaswand wurde mit Mehl und Kleie bestreut. In den unbehandelten inneren Kreis wurden frisch geschlüpfte Jungraupen gesetzt. Die Schalen wurden darauf mit Stoff überdeckt. Der Versuch lief gleichfalls bei konstant 21° C.

In einer ersten Versuchsreihe wurden zwischen Behandlung und Ansetzen der Tiere Belüftungszeiten von 1 bis 5 Tagen gewählt. Von den aufgesetzten je 12 Raupen fanden sich tot auf dem Papier bei Unbehandelt 2, bei der Belüftungszeit von 1 Tag 11, bei 2 Tagen 11 und bei 5 Tagen 7. Nach 6 Wochen war das Mehl in der Kontrollschale völlig versponnen, während sich in keiner Schale mit behandeltem Papier irgendwelche Anzeichen einer Gespinstbildung zeigten.

Daraufhin wurden in einer neuen Versuchsreihe noch längere Belüftungszeiten bis zu 3 Wochen gewählt. Gerade die noch nach 3 Wochen aufgesetzten Raupen fanden sich vollzählig als tote wieder. Gespinste wurden auch hier nur bei der Kontrolle gebildet.

Bei diesem letzten Versuch starb allerdings auch ein Drittel der Raupen in der Kontrollschale ab. Das mag einmal daran liegen, dass ein Teil der Raupen schon einige Zeit ohne Futter lebte. Zum anderen mag auch das

Papier behandelt	Kontrolle	13.2.51	12.2.51	10.2.51	Kontrolle	6.6.51	30.5.51	23.5.51
Eier aufgelegt	13.2.51	13.2.51	13.2.51	13.2.51	13.6.51	13.6.51	13.6.51	13.6.51
also nach Tagen	–	0	1	3	–	7	14	21
Anzahl der Eier	25	25	25	25	15	15	15	15
davon nicht geschlüpft	3	25	25	22	2	5	4	0
gefundene tote Raupen	0	0	0	3	0	10	10	15
Mehl versponnen	stark	nicht	nicht	nicht	stark	nicht	nicht	nicht

Tabelle 4 – Wirkung des Nebelniederschlage von Parex WW auf Mehlmotten-Eiraupen bei Aufsetzen schlupfreifer Eier

Übersetzen der kleinen Räupchen trotz aller Vorsicht nicht immer ohne Beschädigungen abgehen. Die gleichen Versuche wurden darum parallel mit Eieren angesetzt, die kurz vor dem Schlupf standen (Tab. 4).

Hier zeigte sich nun überraschend, dass bei den 0 und 1 Tage alten Nebelniederschlägen keine Raupen aus den Eiern schlüpften, bei dem 3 Tage alten Nebelniederschlag nur 12%. Es liegt also eine deutliche ovicide Wirkung des Gamma-Belages vor, und zwar allein über die Dampfphase, denn die Eier wurden auf den unbehandelten Mittelabschnitt der Papiere gelegt. Nach längerer Belüftungsdauer sinkt die Eisterblichkeit auf 0 ab, aber keine der geschlüpften Raupen überlebt die Passage des benebelten Papiergürtels, selbst nach 3-wöchiger Belüftung.

Wir können also feststellen, dass nicht nur die Eiraupen der Mehlmotte sehr anfällig gegen Gamma sind sondern auch die Eier schon eine hohe Empfindlichkeit gegen Gamma in Dampfform zeigen. Diese beiden Stadien bilden innerhalb des Entwicklungszyclus der Mehlmotte den günstigsten Angriffspunkt für Gamma-Aerosole, deren Wirksamkeit umso nachhaltiger sein wird, je beständiger ihr Niederschlag ist.

Wir können also dahingehend zusammenfassen, dass es gelungen ist, ein Vernebelungsmittel auf HCH-Basis zu schaffen, dessen Nebelniederschlag seine insektizide Wirksamkeit über lange Zeit beibehält. Der Vergleich mit DDT-Aerosolen liegt nahe und wurde eingangs bei der Gegenüberstellung der Wirkstoffe gezogen. Ohne Zweifel wird man unter Verwendung von DDT zu noch längerer Wirksamkeitsdauer kommen können. Dem stehen aber die aufgezählten Vorteile des Gamma-HCH entgegen, nämlich die grössere Wirkungsbreite und die höhere Wirksamkeit, die erst volle Bedeutung gewinnen, nachdem die Wirksamkeitsdauer in so wesentlichem Mass verbessert werden konnte.

DISCUSSION

Mr. **Ketelaar**: 1. Ist es bekannt ob die ovicide Dampfwirkung durch Gamma HCH ohne Zusatz des Parex WW stärker ist? 2. Auf Grund welcher Unter-

lagen meinen Sie, dass die Wirkung des Zusatzes eine Verringerung des Dampfdrucks bezw. der Verdampfungsgeschwindigkeit hervorruft? Es ist z.B. bekannt bei DDT, dass die Kristallform grossen Einfluss auf die Wirkung hat. 3. Welcher Art ist der Zusatzstoff?

Mr. **Sy**: 1. Das wurde nicht untersucht. 2. Es ist auf Glasplatten deutlich zu sehen dass ein Nebelniederschlag aus Gamma allein in kürzer Zeit, ca 2 Tagen (je nach Temperatur und Luftbewegung) verschwunden ist, während der Belag von Parex WW noch nach Monaten merkbar ist und durch seine insektizide Wirkung verrät wie lange er auch HCH enthält. 3. Darüber kann zur Zeit noch nichts gesagt werden.

Mr. **Zinkernagel**: 1. Wie ist die Wirkung auf ältere Raupenlarven? 2. Und die Temperatursabhängigkeit der Wirkung? 3. Wie weit besteht ein „human" toxischer Unterschied gegenüber Rein-HCH? 4. Welches ist die praktische Verwendbarkeit?

Mr. **Sy**: 1. Als sehr resistent hatten sich die verspinnungsreifen Raupen erwiesen. Von den übrigen Stadien wurden nur die Eiraupen untersucht. 2. Die Versuche liefen stets bei 21° um vergleichbare Werte zu bekommen. Es wurde eine praktische Bekämpfung in einem mit *Blatta orientalis* verseuchten Kellerraum durchgeführt, die zeigte dass auch bei niederen Temperaturen ausreichende Wirkung erzielt wird. 3. Kein Unterschied. 4. Als Aerosol mit Dauerwirkung in geschlossenen Räumen gegen Vorratsschädlinge gemäss der deutschen Anerkennung durch die Biologische Bundesanstalt für Land- und Forstwirtschaft.

Mr. **Mayer**: Welche Teilchengrösse wurde bei der Vernebelung festgestellt?

Mr. **Sy**: Die Mehrzahl der Aerosol-teilchen hat etwa eine Grösse zwischen 5 und 15 μ.

Mr. **Keiding**: How was the test-filterpaper placed during treatment of the room? In a horizontal or in a vertical position? On the horizontal surfaces you get much heavier deposits than on the vertical which flying insects prefer.

Mr. **Sy**: Für die Testung wurde das Papier stets horizontal gelegt. Der Niederschlag an senkrechten Flächen ist abhängig von der Oberflächengestalt : je glatter um so weniger, je rauher um so mehr Nebelteilchen setzen sich an. In der Praxis zeigte sich aber selbst gegen so ausgesprochene „Wand- und Deckenbesucher" wie Stubenfliegen eine anhaltende Wirkung.

Mr. **Benning**: Welche Menge HCH pro m^3 Raum wurde zur Vernebelung gebraucht?

Mr. **Sy**: In allen Versuchen einheitlich 75 mg/m^3.

Mr. **Hafliger**: Ist der Vergleich von DDT und Hexa gamma in geschlossenen Schalen stichhaltig?

Mr. **Sy**: Ja, denn es wurde selbstverständlich vor der Aufnahme von Reihenversuche geprüft ob in der gewählten Kontrollzeit von 1½ Stunden eine Beeinflussung durch Gamma Dämpfe erfolgt und zwar in doppelter Weise: 1. Wurden in die Glocken Fliegen in Gazekäfigen eingestellt, so dass die Tiere nicht mit dem Nebelniederschlag in Kontakt kommen konnten und in der genannten Zeit keinerlei Anzeichen einer Intoxikation beobachtet.

2. Wurden parallele Testungen in stehender und in strömender Luft durchgeführt. Die Glocken wurden hierzu durch flache Klötze aufgehoben und aus der oberen Oeffnung die Luft mittels eines Staubsaugers abgesaugt. Bei strömender Luft trat der Knock-down Effekt mit der gleichen Geschwindigkeit ein wie bei stehender Luft. Schliesslich ist eine Dampfwirkung nicht vereinbar mit einer Wirkungsdauer der belüfteten Papiere über vier Wochen und länger. Wurde Gamma in so starkem Masse abgegeben, müsste der Wirkstoff schon nach viel kürzerer Zeit aus dem Nebelniederschlag verschwunden sein.

PIPERONYL BUTOXIDE AND PYRETHRINS FOR THE PROTECTION OF GRAINS AND SIMILAR PRODUCTS FROM INSECT DAMAGE

by
Walter E. DOVE
Baltimore, Maryland, U.S.A.

We have just listened to Dr J.A.FREEMAN's good paper on different kinds of losses and damage that are caused by insects to stored grain. In the U.S. the annual loss by grain insects is now estimated at nearly one billion dollars. The U.S. Department of Agriculture says that the losses of corn stored on farms in the southern portion of our country amount to 9% per month, and that the damage begins in about 60 days after harvest. Much of the principal loss occurs right on the farm. It is estimated that 97% of the corn (maize), 60% of the wheat and 94% of the oats are stored on the farm for at least a part of the year. This means that grain is infested before it is marketed, also, that it is again infested during its transportation, in the larger storage places, and at the mills. Before and after the grain is processed into foods or animals feeds, it is subject to attacks by insects.

Insects develop rapidly in stored grain. Because new generations are frequent, because grain insects live for a long time after they reach the adult stage, and because they develop in small amounts of waste grain, it is easy to understand that storage-places should be thoroughly cleaned and that they should be sprayed with a suitable surface spray. Cadelles and other boring insects penetrate the wood in walls and floors and in such places they are accompanied by other insects which serve as secondary invaders of any newly stored grain.

The most suitable insecticidal spray for killing the concealed insects is a combination of piperonyl butoxide and pyrethrins, known commercially as „Pyrenone", also as „Pybuthrins". The emulsifiable form or an oil solution, containing 1% butoxide and 0.1% pyrethrins is applied about a fortnight before the storage bin is to be filled. This interval allows sufficient time for the walls, floors and partition boards to become dry before the grain is stored. The insecticide is sprayed onto all surfaces of the storage at the rate of a gallon (U.S.) per 500 square foot of surface. This provides about 50 mg piperonyl butoxide („p.b.") and 5 mg pyrethrins per square foot, which has been found satisfactory for the purpose.

The same rate of application of the insecticide is now being used commercially in the treatment of bags and cartons to prevent entry by insects. Cloth or burlap bags are dipped or sprayed with an emulsion and are dried in the shade. For use on paper bags or cartons the outer layer of paper is treated. This is done at the time the paper is made. As the paper passes through a slurry, the active ingredients of the insecticide are deposited on the sur-

face of the paper. Here they are accessible to any insects that may walk over the packaged food. In general the protection of the food from insects last for about a year, sometimes for a longer period.

Another, and a different use is for the protection of stored cheese from cheese mites and skippers. After scrapping the curing boards which are then exposed to sunlight for about a day, an emulsion containing 1% p.b. and 0.1% pyrethrins is sprayed onto the boards and other surfaces of the storage room. The same amounts of active ingredients are also successfully used in parafin coatings of cheeses. These are applied as dips for cheddars.

The extreme safety of p.b. and pyrethrins led to their uses on and about foods. Pyrethrum has long been known for its safety. Now, probably the most extensive toxicological study ever made on any insecticide shows that p.b. is even safer than pyrethrum. In acute oral tests, from 10 to 13 gr of p.b. are required per kg or body weight of experimental rats in order to obtain a lethal dose for one-half the animals (MLD 50). If we compare this amount with 200 mg/kg which is about the MLD 50 for many insecticides, it is evident that the latter are 50 to 65 times more toxic to warm blood animals than p.b. If it is further considered that only one fifth as much p.b. in necessary in combination with pyrethrins, the comparative toxicity of "Pyrenones" or "Pybuthrins" (1/250 to 1/265) is a strikingly impressive one.

The agencies concerned with foods also wanted to know about the results of chronic feeding tests, ones in which the animals consume the insecticide throughout their existence. Extensive tests began with weaned rats that received only treated foods, throughout three successive generations of the animals. When 1000 parts per million parts of food were given, there was no difference in weights between these animals and those receiving untreated food, and no difference in the reproductive capacities of the two groups of animals. At a level of 10,000 parts of p.b. per million parts of food, the rats did not consume so much food and the reproduction was about one-half that of the animals that received untreated food. By means of a colorimetric method which was developed especially for this compound it was found that about 80% of the p.b. passed unchanged through the intestine of the experimental animals. A histopathologic study of tissues of the organs of these animals revealed no abnormalities that could be attributed to p.b. or its combination with pyrethrins.

The extreme safety of p.b. and pyrethrins naturally led to the use of this combination for the treatment of places where foods are processed or handled. The problem of protecting stored grains, however, presented a different problem that required a new approach. In the past the only available means for this problem has been through the use of a fumigant and relatively few of the storage places were constructed to hold the gas for killing insects in the grain. At times a fumigant is undeniably dangerous and not too satisfactory. It is used for the purpose of removing or reducing existing infestations, and it has no residual effects. This means that unless the use has been

100% effective, which is very rare, the infestation builds up again. It is seldom employed, unless there is a substantial infestation and its use has to be repeated as often as it becomes necessary.

Because it was already known that Pyrenone sprays were effective against the insects commonly found in grain, early tests were made with Pyrenone dusts and these were highly effective in the protection of grains. Of great importance was the discovery that high concentrations of p.b. and pyrethrins had no effect upon the fermentation of grain, and of equal importance there was no effect upon germination of treated seeds. The immediate problem, therefore, was to find a suitable powder diluent for the insecticides, one that could be mixed with bulk grain. After testing approximately 100 dusts in a knock-knock machine it was learned that a fibrous talc gave the very best adherence to the grain, that formulations made with it were efficient, and that grain treated with it withstood considerable handling. Its ability to flow from a mechanical feeding device into a stream of grain was very good indeed. "Pyrenone Grain Protectant" ("P.G.P.") was therefore developed which contained 0.8% p.b. and 0.05% pyrethrins in the fibrous talc diluent. The results of extensive tests showed that a treatment rate of 100 lbs. to 1000 bushels of grain was ample for good coverage of the grain, also for protecting it for periods that were much longer than those of normal storage.

Results of practical tests with different stored grains.

No attempt is made in this paper to summarize the laboratory or field tests that were made in the U.S. and in foreign lands, but some specific examples given below will serve as different illustrations on the effectiveness of P.G.P.

Wheat. Pyrenone-protected wheat has been stored from 5 to 8½ months with almost perfect control of grain insects, while untreated wheat showed increasing infestation of insects. At Atchison Kansas, 8000 bushels in two bins were treated in April 1949. This wheat remained in storage without turning until Jan. 1950, a period of 9 months, when detailed examinations were made. Four sections of the first bin showed no insects present, three sections showed from one to three flat grain beetles per quart of grain . . . all dead. Two sections showed eight rice weevils . . . seven dead. In the second bin two sections of eight showed no insects — alive or dead, six showed from one to 25 beetles . . . all dead, and four had a total of 167 beetles with all but 27 dead. The tests represented practically complete control of the insects. For the very best results it is recommended that wheat be treated as soon as it is harvested, so that the treatment will prevent the build-up of an infestation in the grain and will also protect it from outside infestations.

However, at Missoula Montana, 5000 bushels of wheat were treated on March 8th, 1949, which was out-of-condition at that time. Samples of it showed from 3 to 28 weevils and bran bugs per quart of grain. By the end of 7 weeks, samples of this grain showed no evidence of infestation. In August, 5 months after treatment, when the grain was shipped, no living insects could be found in a composite sample.

Corn (Maize). The use of P.G.P. on snapped (unshucked) corn is not expected to

give a high degree of protection from grain insects. This is due to the fact that it is not physically possible for the applied Protectant to enter the shuck in quantity that would afford good coverage of the concealed ears of corn.

Ear corn that has been shucked is more easily but not completely covered with P.G.P., and the degree of protection is correspondingly increased. Counts made of kernel infestations in tests in Louisiana showed:

73.2% more undamaged corn 63 days after treatment
80.0% more undamaged corn 64 days after treatment
82.1% more undamaged corn 93 days after treatment.

These results agree with the general observations and opinions of farmers and others where P.G.P. was applied by the farmer to his shucked corn.

At Quincy Florida, corn treated with P.G.P. sold as high as $36 per ton, as compared to $30 per ton for untreated corn.

At Greenwood Farms, Thomasville, Georgia 800 bushels of shelled (Dixie 18) hybrid seed corn were treated in August 1949. In June 1951, 21 months later, this corn was in perfect condition. The untreated corn was practically destroyed by the spring of 1950.

Oats. In Story County, Iowa, 2000 bushels of newly harvested oats were treated on July 31st, 1950. On inspection 6 months after treatment no insects were found in the treated oats, although nearby bins of untreated oats were commonly infested.

Barley. In Oct. 1949, 720 bushels of barley heavily infested with the Angoumois grain moth and other common grain insects were treated with P.G.P. In May 1950 the untreated barley was a heavy loss while no living insects could be found in the treated barley.

Rough Rice and Brewers Rice. On May 10th 1950 at Sacramento California, 1000 bushels of lightly infested Brewers rice was treated with P.G.P. Three months after treatment the insects were increasing in an untreated bin, but practically none could be found in the treated lot.

Other Bulk Storages. Our co-operators in the U.S. and elsewhere continue to report that P.G.P. is effective on stored beans, rice, and sorghum. One report suggests that it is entirely effective on stored coffee for control of the coffee bean weevil.

No Piperonyl Butoxide in Flour. Flour made from Pyrenone treated wheat has been tested for the presence of p.b., and the colorimetric method which is capable of detecting one part in one million parts of flour, showed no presence of p.b. If any was present the amount was less than one part per million parts of flour. The bran removed from the wheat in these tests showed five parts of butoxide per million parts of flour. Since treatment of the grain made use of 13parts per million, it appears that the remaining 8 parts were removed by aspiration when the grain was cleaned or by addition of water when the grain was tempered for milling.

P.G.P. is effective in protecting grain, but it is not a "cure all". It is not ideal for coping with an already heavy infestation. It does not improve upon nature's methods of drying and preserving stored grain, but it aids natural means of protection.

Some special requirements for stored wheat in certain storages are im-

posed by official agencies in the U.S., which are not general or of importance outside of this country. In order to meet this special use it was felt desirable to develop a different protectant, one having a completely organic base. This imposes certain technical and manufacturing difficulties which add to the cost and reduce the effectiveness.

P.G.P. is largely an inorganic base, a finely ground fibrous talc that is far simpler and more economical to manufacture, easy to apply and appreciably more effective per unit of active ingredients. It is used on all of the grains and is equally effective on wheat, where the absence of the special U.S. requirement referred to above makes this use possible. Unless there is some compelling reason to the contrary its use is recommended for stored grains, of all kinds, including wheat.

P.G.P. aids the goods methods of storing grains by preventing insects from becoming established in the treated grain. It kills insects that are present in moderate numbers, and it does this very well indeed and for long periods of time. It is used without any hazards to the health of man. The increasing use of this protectant is saving money for the farmer and food for everybody.

DISCUSSION

Mr. **Parkin**: Does Dr DOVE consider piperonyl butoxide is toxic to mites by itself or has he worked only with the pyrethrum-piperonyl butoxide mixture? Has he information on mites other than cheese mites?

Mr. **Dove**: Piperonyl butoxide alone is not a good miticide, but in combination with pyrethrins, either as a dust or spray, it is very effective in controlling tropical rat mites and grain itch mites about stored grains. For saphrophytic mites on grain that is out-of-condition there is difficulty in obtaining good coverage which results in poor control. We believe that this emphasizes the importance of treating the grain soon after harvest in order to prevent development of insects and mites.

Mr. **Zacher**: To which chemical group belongs Piperonyl? How does it work on the insect?

Mr. **Dove**: Piperonyl butoxide belongs to the methylene dioxy phenyl group. In combination with pyrethrins it maintains the rapid paralytic action that is characteristic of pyrethrum. At least one paper by CHAMBERLAIN (John's Hopkins) suggests that it inhibits lipase in cockroaches so that they are killed with very small quantities of pyrethrins. The combination is far more stable than pyrethrum used alone, and less expensive too.

THE EFFECT OF BHC AND DDT SMOKES ON INSECTS IN A FARM GRANARY

by

E.A.PARKIN
Slough, England

Introduction

The use under suitable conditions of small DDT- and BHC-smoke generators to control residual infestations of stored-product insects has proved very convenient but, during several years of use in Great Britain, the belief has grown that BHC smokes are less effective against *Oryzaephilus* than against most other species. Large-scale applications of BHC dusts and wettable powders in warehouses, etc., and laboratory experiments with dusts and oil sprays, have shown that *O. surinamensis* L. appears to possess a resistance to BHC greater than that of *Calandra granaria* L., *Tribolium castaneum* Herbst, and similar insects.

In July, 1950, the advice of the Pest Infestation Laboratory was asked for on the control of a residual infestation of insects in a farm granary, before uninfested grain from the 1950 harvest was brought in for storage. A preliminary inspection showed a considerable degree of infestation by a very mixed population of mites and stored-product insects, including *O. surinamensis*. It was therefore decided to clean the building thoroughly; to treat it with BHC-smoke at the maximum practical intensity; and to try to measure the effect of the treatment on the insect population by the use of a simple technique of sample-counting.

Type of building and infestation

The granary had a volume of 13,950 cu.ft. (395 cu.m.) and was divided into three rooms, two on the ground floor and one on the first floor: it communicated through a sliding door with a large barn. The floors were concrete or wooden boards, the walls were limewashed brick or cement, and the building was in a fairly good state of repair, but the outside walls were damp to a height of about 2 ft. (60 cm.). Sacks of animal feeding stuffs and small quantities of loose wheat, oats, and barley were moderately heavily infested with *C. granaria*, *O. surinamensis*, and *Cryptophagus acutangulus* Gyll.: these stocks were removed to another building in which they could be suitably fumigated.

The numerous cracks and crevices in floors and walls contained much debris heavily infested principally by *C. granaria*, *O. surinamensis*, *Crypt. acutangulus*, *Tenebrio molitor*, *Tenebroides mauritanicus*, *Attagenus* spp., and *Lepisma saccharina*.

BHC-smoke treatment

It is well known that insecticidal smokes have poor penetrative powers

and all accumulations of spillage were therefore removed from beams, window ledges, and walls with a stiff brush; the floor was thoroughly vacuum-cleaned. It was not, however, possible in this way to remove all grain residues from deep cracks in floors and partitions. As soon as the cleaning was finished, an estimate was made of the visible insect population by counting the insects found in a wooden frame one-foot (30.5 cm.) square placed on the floor or stood against a wall. Twenty-one pairs of floor and wall counts were made at various places round the wall-floor junction, thus sampling 42 sq.ft. (3.9 sq.m.) of the total area of 686 sq.ft. (64 sq.m.). The total population seen was therefore represented by the number counted in the sample areas multiplied by 686/42 = 16.3. A total of only 25 insects, all normal, was seen in the sample areas at this first count.

The windows were sealed with brown paper, empty sacks, and cotton waste and gamma-BHC smoke generators were distributed according to the volumes of the three rooms and ignited: the dosage was double that recommended for most stored-product insects, and equal to that recommended by the manufacturers for the most resistant species, including *O. surinamensis*. The sliding door leading to the barn was then locked and sealed.

Results of BHC-smoke treatment

After 17 hr. the granary was opened and a sample count made of the various species of insects normal, dead, and affected. The results of this and subsequent counts made on the third and sixth days after treatment are summarized in Table 1.

TABLE 1

Summary of sample population counts after BHC-smoke treatment of a farm granary

Interval after treatment	Total insects counted	Condition of insects		
		Normal	Dead	Affected
1 day	405	51(12.6%)	190(46.9%)	164(40.5%)
3 days	611	25(4.1%)	547(89.5%)	39(6.4%)
6 days	556	12(2.2%)	522(93.9%)	22(3.9%)

As the number of normal insects fell, the proportion of normal *O. surinamensis* beetles rose from 41.2% at the first day to 76% at the third and 91.6% at the sixth. This may have been due not only to a greater resistance to the insecticide but also to a slower rate of emergence of this species from crevices. However, the BHC-smoke residue killed the great majority of *O. surinamensis* beetles within 2-3 days of contact.

DDT-smoke treatment

Because the granary was needed again quickly and the residual population

of insects might still be large enough to be troublesome, it was decided to give a second smoke treatment. DDT was chosen because *Oryzaephilus* does not show any marked resistance to this insecticide when compared with other common stored product insects.

No further cleaning was necessary and, after the last BHC-smoke counts were completed, sufficient DDT-smoke generators were ignited to give slightly more than the dosage recommended by the manufacturers for control of stored-product insects. The granary was left closed for 5 days. The first count showed that the number of insects in the sample areas had risen from nearly 600 to over 1000, of which 99.6% were dead or affected. A few DDT-affected larvae of *Tenebrio molitor* and *Attagenus* sp. were found on the trays on which the smoke generators were standing and could only have dropped there from crevices between the floorboards of the room above.

Three days later an examination disclosed no living insects and the farmer was asked to have the floor thoroughly swept before bringing in the new stocks.

Using the factor of 16.3 to convert the number of insects in the sample areas to total numbers in the stowage, the BHC-smoke treatment had accounted for 9,500 insects and the DDT-smoke treatment had brought out another 7,000. It is evident, therefore, that in spite of careful cleaning by brush and vacuum cleaner a population of at least 16,000 insects had remained safely hidden in cracks and crevices in the building ready to infest new stocks put in store if no insecticidal treatment had been given.

The maximum numbers of insects were counted in the sample areas 3 days after the BHC treatment and 5 days after the DDT and the results for the three most numerous species are compared in Table 2.

TABLE 2

Comparison of the numbers of insects in the sample areas after BHC and DDT-smoke treatments

Species	No. after BHC	No. after BHC + DDT	Increase
Calandra granaria	124	191	54%
Oryzaephilus surinamensis	74	154	108%
Cryptophagus acutangulus	318	604	90%

The table shows that considerably higher proportions of *Oryzaephilus* and *Cryptophagus* than *Calandra* must have sheltered deeply in crevices out of reach of the BHC smoke and had not emerged during the following 6 days to be affected by the residual deposit.

The failure to kill with the BHC-smoke treatment more than 60% of the insects remaining after the cleaning of the granary therefore justified the additional treatment with DDT, but there is no evidence to show that the

DDT smoke would have been 100% successful had it been employed first. It is hoped that an opportunity will occur soon to test this point.

When a final visit was paid 3 months after the DDT treatment, the granary was in full use again for the storage of oats, potatoes, meal, etc., mostly in bags. A careful search for insects was made throughout the granary as there were too few for the sampling technique to give a reliable estimate. A total of 80 insects was found, of which only 14 were apparently normal as follows:

1 *O. surinamensis*	4 *T. molitor* larvae
3 *C. granaria*	1 *Ptinus fur*
4 *Cryptophagus* sp.	1 *Ptinus pusillus*

It is interesting that neither species of *Ptinus* was recorded in earlier counts, although they were known to have been present in the granary some 8-10 years previously. A small proportion of affected beetles was present, indicating that the residual film on the floor retained some toxicity in spite of the sweeping and the use of the granary for storage. The living insects might have been survivors of the insecticide treatment, but could equally well have been introduced after the treatment from the adjoining barn for empty sacks stored there were known to be infested.

DISCUSSION

Mr. Goodwin-Bailey: Could Dr PARKIN say if he aimed at applying a given concentration of either DDT or BHC per 1000 cft.?

Mr. Parkin: The experiment was aimed at reproducing a practical application which could be given by a farmer and the smoke generators were used according to the makers instructions. No attempt was made at accurate dosage.

Mr. Godefroy: Can Dr PARKIN give the quantity of gamma-isomere BHC used for 1000 cft.?

Mr. Parkin: It was not determined.

Mr. Freeman: Is the difficulty of killing *Oryzaephilus* due not only to the habits of the insects in hiding in crevices but also to their high resistance to BHC and DDT insecticides?

Mr. Parkin: *Oryzaephilus* is not particularly resistant to DDT. It is known from tests in the laboratory and in practice to be somewhat more resistant to BHC than several other common species of stored products insects.

Mr. D.W. Williams: Dr PARKIN suggested that *Oryzaephilus* is resistant to BHC and less resistant to DDT. We have found in field trials that *Oryzaephilus* is rather resistant to DDT also, though not so resistant as to BHC. Has Dr PARKIN any experience of this?

Mr. Parkin: *Oryzaephilus* is no more resistant to DDT than many other common stored product insects but may appear so in practice because it hides deeply in cracks and crevices from which it is slow to emerge and come in contact with any residual film of insecticide.

Mr. **Stubbe Teglbjaerg**: Was a vacuum cleaner used for cleaning the granary before treatment and was it used as a blower to get the insects out of the crevices?

Mr. **Parkin**: In this case: no.

Mr. **Nasir**: Could Dr PARKIN give an idea about the distribution of the smoke residues inside the buildings ?

Mr. **Parkin**: No regular observations were recorded in this particular case but from experience we know that the deposition on the floor is at least six times that on the walls and the ceiling. Smoke generators are not suited to the application of residual deposits on walls and ceilings.

DAUERWOLLSCHUTZ DURCH EULANE AUF GRUND 30 JÄHRIGER ERFAHRUNGEN

von

Albrecht HASE

Berlin-Dahlem, Deutschland

Im Jahre 1921 erhielt ich den amtlichen Auftrag Wolltuche, die mit Eulan behandelt worden waren, auf ihre „Mottenechtheit" zu untersuchen. Das positive Ergebnis der Prüfung wurde zunächst zusammengefasst in dem Gutachten über die Schutzwirkung der Imprägnierung mit Eulan gegen Mottenfrass, Berlin 14. Okt. u. 4. Nov. 1921. – Veröffentlicht wurde dieses Gutachten in einer Werbeschrift: „Eulan". Ein neuer Weg zur Mottenbekämpfung. Farbenfabriken, vm. Fr. BAYER & Co., Leverkusen/Rhein – Von MECKBACH, einem Mitarbeiter der Farbenfabriken waren vorher zwei Arbeiten veröffentlicht worden „Mottenechte Wolle" (Umschau Jg. 25; 1921) und „Mottenechte Wolle mittels Eulan" (Melliand Textilberichte Jg. II, 1921). Die Prüfungsergebnisse meiner früheren Untersuchungen und die Art der seinerzeit durchgeführten Versuche (viele hunderte) sind aus dem Schriftenverzeichnis zu entnehmen. (HASE 1927; 1930; 1932, 1933 a, b; 1934 a, b; 1935; 1936 a, b; 1937; BELING 1930).

In der letzten Arbeit „Wollschutz durch Eulane gegen Motten- und Anthrenusfrass" (Melliand Textilberiche 1937) hatte ich das Ergebnis der damaligen 15 jährigen Erfahrungen auf Grund eigener Versuche zusammengefasst, durch Lichtbilder belegt, bei genauer Angabe der Prüfungsbedingungen im einzelnen.

Ich beschränke mich hier auf die Darlegungen meiner neuerlichen Prüfungen von Wollproben, die mit Eulan neu vor 22 Jahren und mit Eulan NK vor 20 Jahren behandelt worden sind. Es ist wohl keine andere deutsche amtliche Stelle im Besitze von gleichalten Proben. Die Stücke haben seit diesen Zeiten im Laboratorium ohne besonderen Schutz gelagert, d.h. sie waren dauernd der Gefährdung durch Motten und Teppichkäfer ausgesetzt und sind, wie die vorgezeigten Lichtbilder und Proben (in durchfallendem und auffallendem Lichte aufgenommen) beweisen, ungeschädigt geblieben (Abb.). – Die Anlage und Durchführung der Untersuchungen 1950 und 1951 sollten ein Urteil darüber bringen, ob die Proben noch die gleichen Eigenschaften besitzen wie vor 22 und 20 Jahren; d.h. motten- und anthrenusecht sind. Die Prüfung der signierten Proben geschah so wie früher bei Zimmertemperatur in dicht schliessenden Schalen, sodass ein Entweichen der Mottenraupen und Anthrenuslarven nicht möglich war. Je 2 Prüfperioden (Ende 1950, Anfang 1951) fanden statt; die Dauer jeder Periode betrug 60 Tage.

Es wurden durchgeführt:

1) Wahlfrass-Versuche. Hierbei befand sich das zu prüfende Wollstück (mit entsprechender Signierung) und ein unbehandeltes Kontrollstück mit der stän-

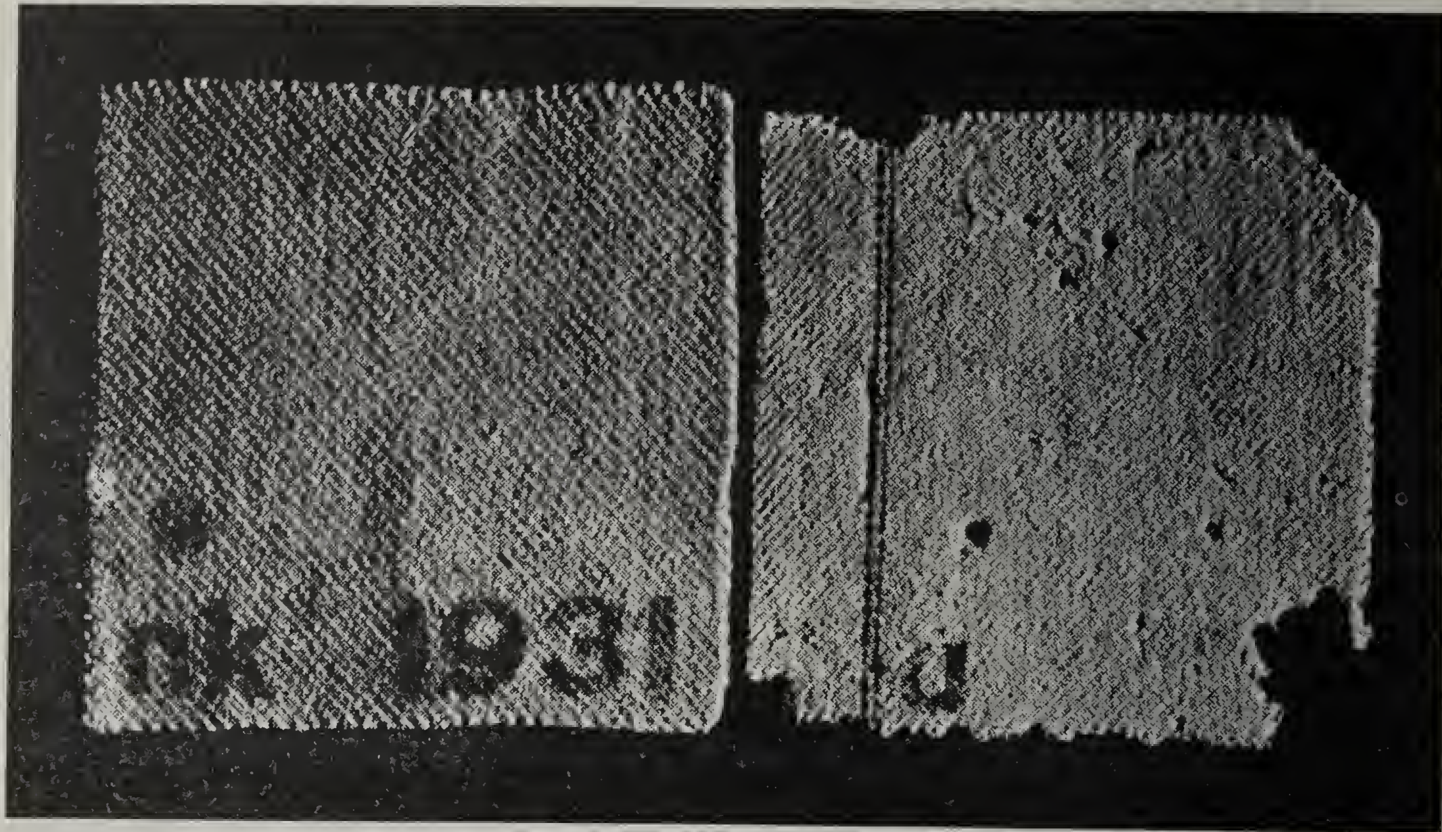

Abb. Wollcheviot mit Eulan NK behandelt Mottenecht nach 20 Jahren Lagerzeit. Wahlfrass-Versuch Orig.

digen Bezeichnung U(=unbehandelt) in einer Schale.

2) Zwangfrass-Versuche. Hierbei befand sich das zu prüfende Wollstuck in einer Schale und ein entsprechendes Kontrollstück (U) befand sich in einer gesonderten Schale.

Die Schalen wurden mit je 20 Mottenraupen und mit 25 Teppichkäferlarven (*Anthrenus verbasci* u. *A.museorum*) besetzt. Die Ergebnisse der Versuche belege ich, so wie früher, durch Lichtbilder, aufgenommen, wie jeweils vermerkt, teils bei auffallendem, teils bei durchfallendem Lichte. Bei Bewertung der Befunde ist noch folgendes zu berücksichtigen. Bekanntlich verspinnen die Raupen der Motten alle möglichen Fremdkörper, auch Fasern der behandelten Wolle beim Kokonbau. Durch dieses Ein- und Anspinnen können ganz leichte Spinnspuren (Rasuren), auch tiefere Rasuren (sog. Köcher- oder Kokonspuren) entstehen, die aber nicht mit normalem Frass zu tun haben. Eine sich verpuppende Raupe nimmt keine Nahrung mehr auf, sie beisst höchstens einige Faserteile ab. Normaler Fressakt ist bei Motten und Teppichkäfern durch reichlichen Kotfall belegt.

Zweifelsohne hat die deutsche chemische Industrie zuerst das Problem des Wollschutzes von neuen Gesichtspunkten aus aufgenommen. Ich verweise auf die historisch wichtigen Angaben von STÖTTER (1947), der an der Ausarbeitung der Präparate massgeblich beteiligt ist. In seiner Arbeit: „Moderne Mottenmittel. Entwicklungsgeschichte des Eulan" (Angew. Chem. A. 59. Jahrg. 1947; Nr. 5/6) führt er aus: „Die Anregung nach besseren Mottenmitteln gab die Verknappung der Wollbestände nach dem ersten Weltkriege und die erschwerte Devisenlage. Das Ziel war die bekannten flüchtigen Mottenmittel

des Haushaltes durch nicht flüchtige also dauernd wirkende Mittel zu ersetzen." Welche vielfachen Bedingungen hierbei zu erfüllen waren ist in Fachkreisen bekannt.

Das Wollschutzproblem ist eines der ältesten in der Kulturgeschichte der Menschen. Auf Grund sorgfältiger Erhebungen betragen auch heute noch die Wollverluste durch Vermottung und Verkäferung Hunderte von Millionen. Die meisten Mottenbekämpfungsmittel für den Haushalt und für die Gewerbe, welche Wolle und Wollprodukte und Pelze verarbeiten, sind unzulänglich oder technisch meist nicht anwendbar. Das Bestreben der deutschen Schädlingsmittel-Industrie, BAYER Werke, Leverkusen/Rhein (ehemals I.G.Farben, Leverkusen), Wollschutzmittel herzustellen, die nach jeder Richtung hin allen Ansprüchen genügen, datiert seit Anfang der 20ziger Jahre dieses Jahrhunderts. Es ist gelungen Präparate herzustellen, die von biologischer Seite aus gesehen einen vollwertigen Wollschutz für die Dauer verleihen und die von technischer und kaufmännischer Seite aus gesehen wirtschaftlich tragbar sind. Es sind die „Eulane". Zur amtlichen Prüfung wurden sie 1921 der Biologischen Reichsanstalt für Land- und Forstwirtschaft, Berlin-Dahlem, übergeben und der Verfasser wurde mit der Prüfung beauftragt. Diese Prüfungen erstrecken sich jetzt über 30 Jahre; sie sind nach allen Richtungen hin ausgeführt worden.

Zusammenfassung.

Die in Betracht kommenden Einzelheiten sind ausführlich dargelegt worden. Eine Urteilsbildung über die Qualität des durch Eulanbehandlung erzielten Schutzes von Wollgut gegen Motten- und Teppichkäferfrass ist möglich auf Grund folgender Tatsachen.

Erstens. Mit Eulan neu und Eulan NK. behandelte Wollproben sind rd. 2 Jahrzehnte lang, ohne besonderen Schutz, aufbewahrt worden. Nach dieser langen Lagerzeit – bei Eulan neu 22 Jahre, bei Eulan NK. 20 Jahre – waren die Proben ungeschädigt, trotz der Möglichkeit eines Angriffes durch Wollfeinde. Diese Tatsache beweist, dass der Eulanschutz eine Dauerwirkung hat.

Zweitens. Nach den langen Lagerzeiten sind dieselben Proben erneut einer zweifachen, sehr scharfen Prüfung auf ihre Motten- und Teppichkäfer- (Anthrenus) Echtheit in verschiedenen Prüfverfahren (Wahlfrass, Zwangfrass) unterzogen worden. Das Endergebnis deckt sich mit den früheren Befunden! Wir können durch sachgemässe Behandlung von Wollgut mit Eulanen einen dauernden Mottenschutz und Teppichkäferschutz erzielen.

DISCUSSION

Mr. **van Emden**: In der einen unbehandelten Probe war der Rand ziemlich unregelmässig. Machen die Raupen demnach auch Randfrass?

Mr. **Hase**: Motten-larven können auch vom Rand der Stoffe her fressen. In

vielen Fällen spinnen sie sich daselbst ein und so kommen Spinnspuren am Rande zustande und die Unregelmässigkeiten an den Rändern der Proben.

Mr. **Zinkernagel**: 1. Wurden diese Untersuchungen nur qualitativ oder auch quantitativ gemacht? – 2. Wurden nur die während 20 resp. 22 Jahren gelagerten Stoffproben tel quel geprüft, oder hat man auch Echtheitsproben durchgeführt um die Gebrauchsechtheit des Mottenschutzes zu kontrollieren. Ledigliche Lagerechtheiten kann man auch mit Silicofluoriden erreichen, aber Silicofluoride lassen keine Nassechtheiten zu.

Mr. **Hase**: 1. Die Untersuchungen sind nur qualitativ durchgeführt worden. 2. Die Proben sind auf ihre Lagerechtheit geprüft worden und sind im Gebrauch gewesen oder gewaschen worden.

Mr. **Parkin**, Auf welchem Substrat haben sie die *Anthrenus*-larven gezüchtet?

Mr. **Hase**: Auf getrockneten Fellen von Ratten untermischt mit toten Insekten.

SECTION XII

MEDICAL AND VETERINARY ENTOMOLOGY

TRIALS WITH DDT AS A MOSQUITO LARVICIDE IN MALAYA

by

J. A. REID
Kuala Lumpur, Malaya

Oil solutions on still water

After the liberation of Malaya in 1945, DDT in kerosine, applied with flit pumps, was tried as an anopheline larvicide, but was abandoned in favour of the familiar oiling with a knapsack sprayer. Because of this apparent failure of DDT as a larvicide for malaria control, we decided in 1947 to start again at the beginning, and so began a long series of field and laboratory experiments. The laboratory work showed, among other things, that DDT in oil as a mosquito larvicide appeared to act mainly as a stomach poison, and that the concentration of DDT in the oil should not be less than one per cent (1). The field work showed that on still water, although doses of DDT as low as half an ounce per acre in oil gave kills of more than 90 per cent after 24 hours, a dose of four ounces was needed to prevent the reappearance of large anopheline larvae by the sixth day after treatment and to give control equivalent to that usually obtained with oiling (2). As a result of this work we recommended that for still water, such as ponds and old mining pools, four ounces of DDT per acre should be applied as a five per cent solution in half a gallon of a strongly spreading oil such as diesel; kerosine and gas oil are unsuitable as they do not have a strong enough spreading pressure. The solution to be poured or squirted on at intervals of a few yards and left to spread. The cost of this treatment is about a tenth that of ordinary oiling.

Oil solutions on flowing water

With the knowledge gained from the laboratory and field work on still water, we turned to the main problem of destroying *Anopheles maculatus*, the principal malaria carrier of Malaya, whose larvae live in small bodies of flowing water such as ravine streams and seepages. We soon found that although the same doses of DDT in oil were effective if applied carefully and evenly drop by drop from a pipette, they were ineffective if applied at intervals of several yards as on still water, even if a special oil (Shell "Malariol H.S.") with a spreading pressure of nearly 36 dynes per cm, was used. Side pockets in the streams, seepages half way up the banks, obstructions such as sticks and leaves or strong films and scums, prevented the oil solution, if it was applied at intervals, from reaching all the larvae, Trials were then made with a flit pump, using the same quantities of DDT/oil solution, but much of the fine mist spray blew away without reaching the water, and control was no better than when the solution was applied at intervals. The flit pump was also exceedingly tiring to use as the handle has not been lengthened, and one had to walk stooping up the middle of a stream to keep the nozzle near the water surface (3).

Probably it was the combination of unsuitable flit pumps (there are well over 200 miles of drains to be oiled every week in the Kuala Lumpur Town area alone), and the poor spreading powers of kerosine, which was largely responsible for the failure of DDT as a larvicide when first tried in Malaya in 1945-46.

The need for a special sprayer

At this stage the work had shown that DDT in diesel oil was effective against *Anopheles maculatus* theob., if it was applied evenly in fairly large drops, but we lacked any practical means of doing this, pipettes being much too slow except for experiments. Ordinary oiling with a knapsack sprayer uses about 25 gallons per acre, DDT in oil only half a gallow, consequently a suitable sprayer would have to be roughly fifty times as economical as a knapsack sprayer. Flit pumps are as economical as this, but produce a mist of tiny droplets which blow away. At that time we knew of no sprayer which would meet these requirements, and so turned our attention to emulsions and wettable powders which could be diluted with water and applied with an ordinary knapsack sprayer.

Emulsions and wettable powders

As in previous experiments on flowing water, a five per cent solution of DDT in oil, applied evenly with pipettes or dropping bottles, was the standard with which the other methods were compared. The results of some of these trials are shown in the Table.

TABLE

Comparison between different formulations of and methods of applying DDT as a larvicide against ANOPHELES MACULATUS

formulation	method of application	No. of trials	ounces insecticide per acre	No. larvae per trial: just before treatment	No. larvae per trial: 1 day after	% control 1 day after treatment	% larvae 4th instar (full grown or nearly so (7 days after treatment
5% DDT in "Malariol"	dropping bottle	3	4.8	100	3	97	0.8
" "	„Eagle Force Oiler"	4	4.2	174	12	93	0.8
DDT emulsion	Knapsack sprayer	3	4.6	123	3	97	0.9
DDT 25% wettable powder	"	2	4.4	248	109	56	8.9
Comparison (no treatment)	nil	10	–	59	81	−37	26.0

The wettable powder was inferior to the oil solution or emulsion, but there was little to choose between the last two. Indeed, more recent experiments suggest that a good emulsion may give rather better control than an oil solution. The spreading of the latter is always liable to some obstruction from films and scums, even if oils with very high spreading pressures are used, but the diluted emulsion, sprayed copiously all over the water does not depend much on spread to reach the larvae. The poor results with the wettable powder may be due to the fact already mentioned that DDT as a larvicide appears to act mainly as a stomach poison. Solutions and emulsions form oil films on the surface of the water which the larvae are constantly swallowing. Wettable powders do not form such films and in consequence the larvae probably swallow less DDT, and this is in solid particles which are known to be less toxic than oil solutions. Following on this work we recommended that DDT emulsions should be tried as alternatives to oiling. The type of emulsion that has been developed in cooperation with the Shell Co., is a 25 per cent concentrate of DDT in a blend of aromatic gas oil and mineral turpentine, plus an emulsifying agent, the whole adjusted to a specific gravity less than water. For use the emulsion is diluted about one in 200 in a knapsack sprayer. The cost should be between a tenth and a twentieth that of oil.

The 'Eagle Force Oiler'

Meanwhile the search for a satisfactory sprayer for using oil solutions of DDT against *Anopheles maculatus* has been continued, and lately fairly good results have been obtained with a small light hand ejector, the "Eagle Force Oiler", which was kindly brought to our notice by Dr. Wilbur G. DOWNS of the Rockefeller Foundation. This little instrument which holds 100 cc, squirts a jet of 1 cc to a distance of 15–20 feet, and most important of all the jet breaks up into a spray of large drops which fall in a long ellipse about two square yards in area, at the rate of roughly 1000–1500 drops per square yard, i.e., the drops are about 0.5–1 mm in diameter. The results obtained are shown in the Table. With this instrument, weighing only a few ounces, carried in one hand, and a reserve supply of a pint or two of solution, a man can walk up the banks of drains or small ravine streams squirting about once every four paces, and can see how his spray is falling by watching the rainbow colours formed by the spreading oil drops. With an emulsion he has to carry a knapsack sprayer weighing about 44 pounds when full, and even immediately after he has passed there is nothing to show that any spray has been applied. Even with oil solutions of DDT there is nothing to be seen the next day, and this is a disadvantage compared to ordinary oiling which burns the grass on the banks and leaves other traces, such as smell, by which the work of the oiling labourers can be checked. It must be admitted that for the control of *Anopheles maculatus* in Malaya, heavy oiling probably gives a rather greater margin of safety than any DDT treatment, but the economy of the latter is so great that it outweighs the disadvantages.

Benzene hexachloride

BHC, in the form of oil solutions, wettable powders and emulsions, was included in the various trials, but there is not time here to give the figures which will be published elsewhere. As with DDT, the wettable powder was much less efficient than an oil solution or emulsion, but in general BHC as a larvicide does not seem to have much advantage over DDT, and is more expensive. The ratio of toxicity between gamma BHC and DDT is about 10 to 1 in favour of BHC for adult mosquitoes, but only about 3 to 1 or less for larvae.

Present position

The present position in Malaya may be briefly summarised as follows. Routine malaria control of urban areas, in addition to relying on permanent works such as subsoil drainage, still makes use of ordinary oiling to prevent the breeding of *Anopheles maculatus*, but it should now be possible to substitute DDT emulsions with a great saving of cost. If oil solutions of DDT can be used, the saving in bulk as well as in cost, would be so great that large changes and economies in anti-malarial staffs would probably follow. We have not relinquished our efforts to find the ideal sprayer for this task, and meantime the "Eagle Force Oiler" will be issued for wider trial. In Penang and one or two other places, BHC wettable powder (Gammexane P. 520) has recently been used, and for still water, oil solutions of DDT have replaced ordinary oiling in Kuala Lumpur.

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DISCUSSION

Mr **Buxton** enquires after physico-chemical methods to measure the spreading power of oil on the surface of water.

Mr **Reid** replies that a film strength of 25 dynes should be aimed at. The oil which was used as the solvent for DDT ran as high as 36 dynes.

FACTORS IN THE ATTRACTIVENESS OF BODIES FOR MOSQUITOES

by

A.W.A.BROWN

Ontario, Canada

The foolowing is a brief report of an investigation performed during the past three years on funds granted by the Defence Research Board of Canada. Workers associated with me in this project include D.S.SARKARIA, D.G. PETERSON, R.P.THOMPSON, W.L.SIPPELL and G.T.CROSSON.

It was hoped that simple experiments involving significant numbers of test animals could indicate the preferences of female *Aëdes* mosquitoes in approaching objects, and thus evaluate the factors which attract them to man. *Aëdes aegypti* L. was used in the laboratory, with model apparatus set up in a 360 cubic foot cage. In the field, the species involved were *A. intrudens* Dyar and *A. trichurus* Dyar in Ontario and *A. punctor* Kirby, *A. pionips* Dyar and *A. communis* Deg. in Labrador.

The field experiments were conducted with the aid of a pair of robots or "dummy men". These consisted of stainless steel tanks, 24 inches high and elliptical in cross-section, holding 100 lbs. of water; they were clothed in a felt undershirt and a black crepe jerkin, mounted on legs and set up 6 feet apart in suitable forest glades. The water temperature was maintained at 98° F by an electric knife-type heater thermostatically controlled; the water was stirred. With 125-watt heaters, maintenance of a clothed robot at body temperature continuously day and night required the heating circuit to be closed for approximately 40% of the time (checked by an electric clock). This represents an energy expenditure of 50 watts, roughly equal to that of a resting man.

Warmth as a Factor

Evidence has been adduced by DELONG et al. (1945) and CHRISTOPHERS (1947) that warmth is a factor in the attractiveness of surfaces to *Aëdes aegypti.* However, PARKER (1948) has recently presented evidence that warmth is not attractive per se but only serves to increase the attractiveness of moist bodies.

In our experiments, the number of landings per minute of mosquitoes upon the clothing of the robots was taken as the criterion of attractiveness. It was found that a robot maintained at human body temperature and in dry clothing was approximately 3 times as attractive as one filled with cold water (48° F to 64° F). Here only the crepe jerkin was used and the surface temperature on the warm robot was 14 to 17° F higher than the cool one. When the felt undershirts were also used this differential fell to 4° F only, and there was only a slight difference between the numbers of mosquitoes attract-

ed to each. When this clothing was moistened, the temperature differential increased again due to the conductive properties of water, and the warmer robot became nearly twice as attractive as the cooler one.

With *Aëdes aegypti* in the laboratory a pair of billiard balls that had been heated in water to the required temperatures and then dried were mounted 16 inches apart on a board suspended 4½ feet above the floor of the cage. One ball was made 20° F warmer than the other and the criterion was the number of times that the mosquitoes touched the balls per minute. The warmer ball always proved to be the more attractive than the cooler up to a temperature of 110° which in turn proved more attractive than a ball heated to 130° F. Therefore warmth is attractive irrespective of moisture.

Radiation versus Convection

An early observation by HOWLETT (1910) indicated that convection was the factor in the attractiveness of warm bodies to *Aëdes* mosquitoes. However, recently BECK & MILES (1947) have implied that radiation in the infra-red range is a factor in the olfactory responses of cockroaches.

Radiation effects therefore were separated from convection currents by the interposition of an air-tight window of thallium bromoiodide (KRS-5), permeable to infra-red radiation, between a warm object and the mosquitoes. A billiard ball warmed to 110° F was placed in a 6-inch sleeve, the KRS-5 window (3 inches diameter, ½ inch thick) was placed above it in air-tight fashion, and a cone of black nylon veiling was set upon it. The numbers of mosquitoes landing on the cone were counted both when the ball was in position and alternately when it was withdrawn. It was found that, whereas without the window the presence of the ball was four times as attractive as its absence, with the window in position there was no difference in the numbers whether the ball was present or not. Similarly, when two sleeves were used and one ball was 20° F warmer than the other, the presence of windows on the sleeves abolished the normally higher attractiveness of the warmer ball.

The rôle of radiation in attractiveness was also checked by means of a LESLIE cube, a tin of 10'' side which contained water heated to 92° F and with adequate stirring. The four vertical faces, which all were equally warm, were treated or painted differently to give them widely different radiant emissivities. It was found that the attractiveness of the surfaces, whether they were flat black of high radiant emissivity, or polished metal of low emissivity, or intermediate, remained almost identical. Therefore the attractiveness of warm objects it independent of their radiation.

Moisture as a Factor

The role of moisture as an attractant to mosquitoes has already been cited by several workers. In order to investigate the effect of air-borne water vapour, a special olfactometer was devised, since the standard WIETING-HOSKINS model was not found suitable for *Aëdes*. It consisted of two BUCH-

NER funnels, 3½ inches in diameter, set in 4½ inch holes 16 inches apart in a board. The air-stream cascaded over the sides of the two BUCHNER funnels into tins and was thence withdrawn. The flow-rate and temperature of the air were controlled with standard apparatus to deliver 5 litres per minute to each port. The ports were covered with brown veiling and the number of times the mosquitoes approached to within a half inch were counted. It was found that air to which water vapour had been added (resulting in a relative humidity of 80-90% at the port) was 3 to 5 times as attractive as air dried by passage over calcium chloride (giving 15-20% R.H. at the port). If however the relative humidity of the room air was raised to 80% (from the normal 35-65%) the moistened port became only 1,5 times as attractive as the dry one.

It was found also that moistened clothed billiard balls were 5 to 7 times as attractive as their dry counterparts (whether black or white), at 40% R.H. and a room temperature of 80° F. In the field experiments a robot whose clothing was moistened proved to be 2 to 4 times as attractive as its dry counterpart - when the weather was warm.

However, when the air temperature fell below 60° F, the moist clothing became less attractive than the dry, despite the surprising finding that its surface temperature was 1-3° F warmer.

Carbon Di-oxide as a Factor

Carbon di-oxide was discovered to be an activator for mosquitoes by RUDOLFS (1922) and has been used as a field attractant by HEADLEE (1941). When tested with *Aëdes aegypti* in the olfactometer already described, a mixture of 10% CO_2 in dry air was found to be twice as attractive as dry air alone and slightly more attractive than moist air. When 100% CO_2 vapour was passed through the olfactometer it was found to be no more attractive than dry air and less attractive than moist air. Similarly 100% CO_2 proved to be only two-thirds as attractive as 10% CO_2. That there was an optimum concentration of CO_2 around the ports could also be demonstrated by emitting it through an orifice at the centre and top of a tier of disks and observing the movement of mosquitoes outwards and downwards as the speed of emission was increased.

Field experiments were conducted by emitting carbon di-oxide at 2 litres per minute through artificial heads on the robots. When 10% CO_2 was thus emitted it caused the head and body of the robot to become 1,5 times as attractive as a robot emitting air alone or no air at all. When 100% CO_2 was emitted, the attractiveness of the body was doubled and that of the head was tripled. But if a robot was clothed in a jerkin soaked in CO_2-saturated water it proved to be no more attractive than one soaked in fresh water. However, when this experiment was repeated with clothed billiard balls in the laboratory, the CO_2 treatment proved highly attractive to *Aëdes aegypti*.

Other Vapours as Attractants

There is no clear evidence in the literature of chemical attractants for mosquitoes. A number of compounds and mixtures known to be attractive to adult *Musca domestica* L. were therefore tested in the olfactometer with *Aëdes aegypti*. None proved to show attractiveness of any statistical significance. Acetic acid, lactic acid, ammonia, trimethylamine, benzaldehyde and molasses were unattractive at all concentrations; ethyl alcohol, ethyl butyrate and beer appeared occasionally to evoke a response in a swarm of mosquitoes. When human sweat was collected from the armpits of Caucasians and its vapour passed through the olfactometer, it proved to be repellent at high concentrations but significantly attractive at low concentrations. When a robot in the field was clothed in a jerkin which had been used as a towel to wipe sweat from Caucasians, it proved significantly more attractive than a clean jerkin of similar moisture content. The results are in agreement with those of WILLIS (1947) and DELONG (1949) who found human sweat to be attractive when tested in the WIETING-HOSKINS olfactometer.

Since carbon di-oxide is a narcotic for insects, other narcotic vapours were tested for their attractiveness to *Aëdes* mosquitoes in the field. When air was bubbled through their liquid phases to issue from the robot's head at 2 litres per minute, chloroform proved unattractive, but ether (diethyl) and gasoline (petrol) vapour proved to be significantly attractive.

Sight as a Factor

It remained to evaluate the importance of visual factors as compared with the airborne factors already studied. The experiments were performed with deer-mice (Peromyscus bairdii) and a number of plastic boxes (8" × 4" × 4") such as are used in refrigerators. A visible mouse in an airtight clear box, unsmellable, was found to be slightly more attractive than an invisible mouse in a perforated opaque box; a visible mouse in a perforated box, now smellable, was 60% more attractive than the visible mouse in the airtight box. A visible mouse in an airtight box was 3,7 times as attractive as a similar but empty box. A visible mouse in a perforated box was 6,7 times as attractive as a similar empty box. These results tend to show that the visible factors are no less powerful than the airborne factors in attracting *Aëdes aegypti*.

It must be stressed that these mice were in no way inhibited from their natural movements. When compared with mice immobilized by narcosis with a barbiturate, it was found that mobile animals were approximately twice as attractive as motionless ones. Similarly, when a moving black canister emitting moist air was compared with a stationary one, it was found to accumulate approximately twice as many mosquitoes.

Light Reflection as a Factor

Laboratory experiments have shown that a black ball attracted approximately 5 times as many *Aëdes aegypti* as a white one. In the field it was found

that a robot clothed in black crepe attracted 4 to 10 times as many wild *Aëdes* as one clothed in white broadcloth. Then when different shades of a colour were compared, the darker shade attracted more than twice as many mosquitoes as the lighter. Similarly, when cloths dyed with luminescent pigments (fluorescent satins) were compared with their normal colour counterparts, the latter were more attractive by reason of their inferior brightness, When cloths of different texture but of similar colours were compared, the crepes and broadcloths (dull) proved to be more attractive than satins (bright), while the nylons were the least attractive of all. The relation of colour hue to attractiveness is not a simple one, and work is now in progress to compare the attractiveness of 32 different cloths with their reflection spectrum in the visible and ultra-violet range.

Contour as a Factor

The researches of VON FRISCH on bees and work on robber-flies have demonstrated the importance of angularity or richness of contour in an object, since it enhances the flicker effect when perceived by compound eyes. The following observations confirm the importance of the flicker effect in the response of *Aëdes aegypti* to objects.

With the LESLIE cube, it was found that a black enamel face was significantly more attractive than a flat black face, and a glass mirror more attractive than a polished metal surface. It may be concluded that this is due to the mirroring surfaces presenting a flicker effect as the perceiving mosquitoes move across them. The attractiveness of a black enamel face could in fact be significantly increased by moving pinpoints of shadow across it, and not by pinpoints of light.

The importance of contour in attractiveness was demonstrated by the use of cardboard cubes carrying black and white in equal amount in a checkerboard or a striped pattern. It was found that as smaller checks or narrower strips were presented, the black-white interfaces thus increased, attractiveness of these objects rose proportionately.

In summary, convective warmth, water vapour and carbon di-oxide are attractive to adult *Aëdes* mosquitoes. Chemical attractants are inoperative, with the exception of narcotics like ether or petrol, and human sweat. These airborne factors are no more powerful than the visual ones, which include movement, contour or flicker, and dullness of reflecting surfaces.

DISCUSSION

Mr. **Stride** suggests that the expected stimulatory effect of a warm surface might give a false impression of attractiveness, owing to the method of recording attractiveness.

Mr. **Brown** replies that there is no absolute method of recording attractiveness. The "landing rate" was arbitrarily taken as the most suitable method, regardless of its limitations.

Mr. **Bequaert** asks which of the factors influencing attractiveness are most active in nature.

Mr. **Brown** replies that he believes the dullness of the surface (black *versus* white) is the most decisive factor. After that comes moisture, especially at high temperature; then warmth, particularly at low temperature of the air. Carbon di-oxide is of a secondary order, though still highly significant.

Mr. **Theodor** asks how the disturbing influence of the presence of an observer could be avoided.

Mr. **Brown** replies that the observers stationed themselves on the average 20 ft. from the robots, but as the light failed they approached even to within 6 ft. Nevertheless speaker was reasonably confident that the observers did not themselves attract mosquitoes at the expense of the robots.

Mr. **Reid** asks what might be the main attractive factor for nocturnal mosquitoes, if different-reflection values are the most important for day-time *Aëdes*.

Mr. **Brown** answers that his experience is restricted to semi-crepuscular *Aëdes*, i.e. mosquitoes which are most active in the evening but, nevertheless, do bite all day. It is hoped that, eventually, these studies can be extended to *Anopheles*, in order to answer the question which has been put.

NOTA SOBRE UNA ESPECIE DEL SUBGENERO PHALANGOMYIA DEL GENERO CULEX ENCONTRADA EN LA PROVINCIA DEL AZUAY (ECUADOR): CULEX ARCHEGUS DYAR 1929 (DIPTERA–CULICIDAE)

por
Roberto LEVI-CASTILLO
Guayaquil, Ecuador

Esta especie ha sido encontrada en la población de Monay (Azuay) localizada a 2.500 metros sobre el nivel del mar, en la Hacienda „Monay" de la familia Sojos y junto a las orillas del rio Tomebamba, en un pozo destinado a pudrir hojas de cabuya para obtener las fibras. El criadero tenía aguas pútridas, de color verdoso y con un pH de 5.8 y una temperatura de 14° C hallándose una abundancia de larvas y pupas, las que van a ser descritas por vez primera para la ciencia en este trabajo.

Culex (Phalangomyia) archegus Dyar 1929 [1)]

Larva. Cabeza redondeada mas ancha que larga. *Antena* larga, ahusada con un penacho grande de pelitos en la porción subterminal, con dos pares de pelos largos en la porción terminal, el cuerpo recubierto en sus ¾ con espiculitas. *Pelo preantenal* formado por varios elementos que usualmente son entre seis i ocho, espinosos, llegando hasta mas allá de la mitad de la antena. *Pelo exterior dorsal* con tres a cuatro elementos espinosos. *Pelo interior dorsal* con cuatro a seis elementos espinosos. *Peinilla del octavo segmento* con multiples espinatas alargadas formando una mancha. *Sifón de aire* largo, cuatro y media veces mas largo que ancho con un *Pectén* formado por trece a quince escamitas triangulares, afiladas y formando estrias o dientecitos, cada espinita individualmente con tres a cinco dientecitos; penachos del pectén en número de cinco de dos elementos cada uno, localizados mas allá del pectén. Segmento anal mas largo que ancho, finamente espinulado en su mayor extensión. *Pelo lateral* doble y largo. *Brocha dorsal* compuesta por tres elementos largos y fuertes. *Brocha ventral* compuesta por ocho pelos, formados por cuatro elementos cada uno, muy desarrollados y largos.

Pupa. (Según KNIGHT & CHAMBERLAIN 1948) *I Segmento:* Pelo 10 desarrollado y doble, muy largo, Pelo 2 base gruesa muy ramificado; *II Segmento* Pelo 8 desarrollado y largo, Pelo 2 largo y delgado; *III Segmento* Pelos 2 y 5 ramificados y largos, Pelo 7 largo; *IV Segmento* Pelos 2 y 5 ramificados y largos, Pelos 4, 6 y 7 largos; *V Segmento* Pelo 2 ramificado y largo, Pelo 5 larguísimo y diramificado; *VI Segmento* Pelo 2 diramificado y muy largo, Pelo 5 ramificado y largo, Pelo 7 largo y simple; *VII Segmento* Pelo 2 mediano y diramificado, Pelo 6 largo y simple, Pelo 5 mediano y diramificado, Pelo

1) DYAR, H.G. – American Jn. Hygiene, Baltimore, 9 (2): 511, 1929.

8 multiramificado y muy desarrollado; *VIII Segmento* Pelo 5 mediano y simple, Pelo 8 multiramificado y muy desarrollado y espinuloso. *Trompeta* mas larga que ancha con abertura triangular, redondeada en los bordes angulares, ahusada y muy recorrida por sinuosidades. *Agallas Pupales* redondeadas y con una costilla fuerte en su porción central; pelos terminales pequeños.

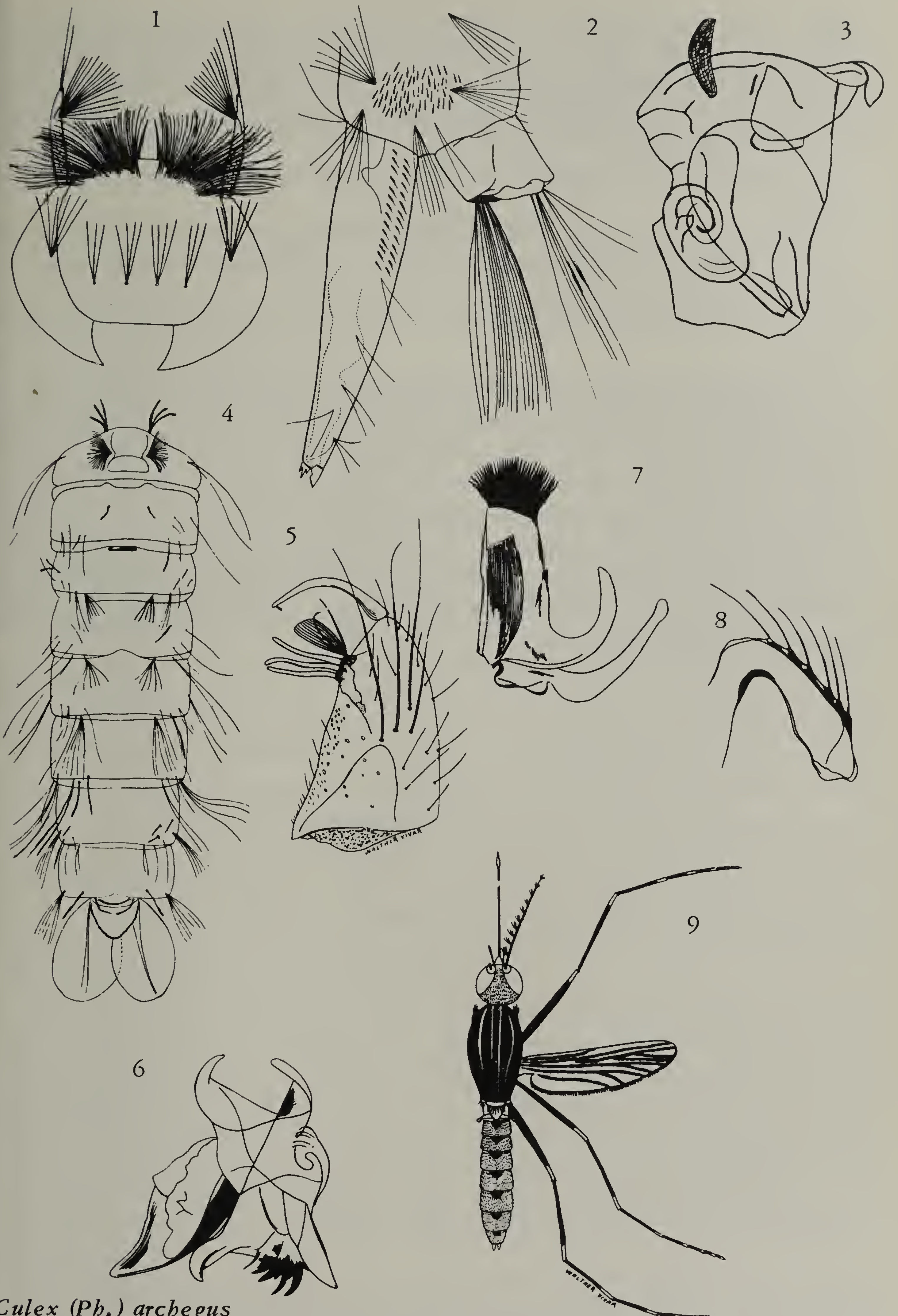
Adulto. Prosbocis mediana, ligeramente engrosada cerca de la punta, café-verdosa. Palpos delgados y largos en los machos; cortos y lobulosos, muy revestidos de cerditas en las hembras, todos son de una coloración verde aceituna con cerditas negras, que al secarse toman una coloración café claro. Vértice con el integumento obscuro y revestido de escamas blancas plumosas que lo recubren completemante y llegan hasta el borde de los ojos. Occipucio obscuro revestido de escamas blancas plumosas tal como en el vértice.

Lóbulos protoráxicos destácanse revestidos de escamitas doradas y pelitos negros. Mesonoto con tres rayas de escamitas cafés apelmazadas y manchas circulares de las mismas en la base de las alas, revestido el disco de cerditas doradas, con espacios mas claros entre los grupos de escamitas apelmazadas. Escutelo trilobar siendo el lóbulo mediano mayor que los laterales continuándose en ellos la coloración del mesonoto, estando revestidos de cerdas piliformes obscuras. Postnoto desnudo y de coloración café clara. Abdomen café aceituna con bandas basales blancas que se engrosan en los segmentos abdominales formando bandas gruesas que lo recorren lateralmente; con el penúltimo segmento revestido de escamitas blancas con un espacio café obscuro central. El vientre está recorrido por una banda obscura central hacia la que convergen las manchas blancas laterales, formando manchas claras látero-ventrales.

Las patas son largas, aumentando ligeramente el porte a medida que se desplazan de adelante hacia atrás, siendo las patas posteriores ligeramente mayores que las medias y estas que las anteriores, siendo todas negras con los fémures y tibias revestidos de manchas blancas en la porción terminal y los segmentos con manchitas blancas notables en las porciones basal y terminal.

Las alas son como las de los otros *Culex*, revestidas de escamitas obscuras.

Terminalia Masculina. La pieza lateral es de forma triangular, con la porción terminal cónica, revestida en su porción externa con múltiples cerdas fuertes y largas; en la porción basal presenta micropilos y sinuosidades. Lóbulo subterminal prominente, bajo, con tres filamentos sinuosos, siendo el mediano ligeramente recurvado terminalmente, saliendo los tres de una base tubercular; un filamentito delgado, mas corto que los otros y ligeramente recurvado en la punta; una hojilla en forma de basto, bastante grande, ovalada y una cerda largo que tiene la forma de filamento, casi del mismo largo que los otros. Clasper recurvada, engrosada centralmente y ahusada hacia afuera, con una escamita triangular, de ángulos redondeados en la porción terminal. Placa mesosomal con la porción superior corta, la inferior recur-



Culex (Ph.) archegus

Fig. 1 — Cabeza de la larva. Fig. 2 — Porción caudal de la larva. Fig. 3 — Céfalotórax de la pupa. Fig. 4 — Segmentos abdominales de la pupa. Fig. 5 — Coxita. Fig. 6 — Placa mesosomal. Fig. 7 — Décimo esternito. Fig. 8 — Novenos térgitos. Fig. 9 — Representación esquematica del adulto.

vada y en forma de pulgar, con varios dientecitos intermedios; obsérvase un diente muy grande en la base que luego se torna ahusado hacia afuera, proyectándose con respecto a la placa mesosomal hacia afuera. Décimos esternitos con las puntas recubiertas de múltiples espinitas y un brazo recurvado en forma de alfange en la porción basal. Novenos térgitos formados por un arco delgado con diez cerditas medianas, que nacen de pequeños tuberculitos basales.

Esta especie es la primera del subgénero *Phalangomyia* que ha sido hallada en la República del Ecuador, habiendo la posibilidad de hallar otras a lo largo del callejón interandino.

Summary

The taxonomic status of *Culex (Phalangomyia) archegus* Dyar 1929 is hereby discussed, the larvae and pupae of this species are new to science and are described for the first time in this paper. This species is found in the small town of Monay in the province of Azuay in Ecuador, at an altitude of 2.500 meters above sea level, near the shores of river Tomebamba, in a small water hole made for the purpose of rotting the cabuya leaves to get the fibres for rope-making. The breeding places have putrid waters with a pH of 5.8 and a temperature of 14° C. The author has observed a great number of larvae and pupae in this breeding place.

COMPARACION DE LA EFECTIVIDAD Y ACCION DE LOS INSECTICIDAS ROTHANE (TDE), GAMMEXANE Y DICLORODIFENILTRICLOROETANO (DDT) SOBRE LOS MOSQUITOS ECUATORIANOS AËDES CAMPOSANUS DYAR Y CULEX QUINQUEFASCIATUS SAY

por

Roberto LEVI-CASTILLO

Guayaquil, Ecuador

Métodos y procedimientos seguidos en la experimentación sobre insecticidas de contacto en emulsoides 50%

Se hicieron diluciones de los insecticidas en orden ascendente es decir 0.5%, 1%, 1.5%, 2%, 2.5%, 3%, 3.5%, 4%, 4.5%, 5%, 5.5%, 6%, 6.5%, 7%, 7.5%, 8%, 8.5%, 9%, 9.5%, 10%, 20% y 25%. Para obtener los resultados por contacto se usaron las cajitas especiales diseñadas por el autor de este trabajo con una dimensión „Standard" de 30 cm de largo por 25 de ancho, por 15 de alto, las que tenían una ventanita de tela plástica a fin de no entorpecer los resultados por la presencia de catalizadores, y la que tenía por objeto servir para la observación de los resultados al introducirse en la caja respectiva los cartones con las diluciones correspondientes, pulverizadas sobre ellos. Se introducían diez adultos tomando tiempo cronográficamente, para el tiempo necesario que demorarían en perecer por acción residual del insecticida. Las observaciones eran anotadas y por tres veces se introdujeron diez adultos de cada especie completando tres ciclos o sean 30 mosquitos, tomando tiempo cada 15 minutos para observar los muertos y los que aún se mantenian vivos, hasta la muerte de todos los mosquitos del lote. Se realizaron 88 experimentos sobre adultos y el mismo número sobre larvas con el mismo ciclo de diluciones, determinando así el tiempo mínimo de muerte y el tiempo máximo de muertes en los tres insecticidas. En el control no se anotaron los muertos por no tener ningún objeto que el de servir como testigo de la acción insecticida del "Rothane", "Gammexane" y el "Neocid".

Las larvas se colocaron en vasos de cartón conteniendo teóricamente 100 cc de agua, pero en realidad 105 cc para compensar por la evaporación. Se colocaron por medio de un gotero de boca ancha unas 10 larvas en cada vaso y se usaron las de cuarto estadio; no se les dió alimento alguno y se hicieron observaciones de mortalidad durante las 4, 12, 24 y 48 horas. Todas las larvas que no podían controlar sus movimientos, esto es salir a la superficie, subir o bajar en el vaso en una forma normal, se las consideró como muertas o intoxicadas mortalmente. El número mínimo fué de tres veces por dilución del insecticida.

Se tomaron las diluciones y de estas 1 cc agregándosele esta cantidad a 99 cc de agua destilada, dando una dilución de 10.000 partes por peso del insecticida; luego a un centímetro cúbico de esta dilución se le colocó en otros 99 cc de agua destilada observándose así una dilución de una parte en 1.000.000 del insecticida en solución.

Las emulsiones „Standard" que se usaron en 22 diluciones se usaron en redilución de 10.000 partes y 1.000.000 de partes por una, pues sería la forma que mas se parecería a las aplicaciones prácticas de larvicidas en el campo.

Al efectuar las soluciones se lavaron perfectamente las pipetas, frascos y aparatos usados en agua corriente, luego en acetona para eliminar cantidades de insecticida que pudieran interferir en las experiencias y aumentar el porcentage. Las pesadas se realizaron en una balanza de precisión de tal modo que la máxima exactitud se observó en los pesajes de los insecticidas, para impedir que se observaran resultados imperfectos. Se usaron pulverizadores del tipo „Flit" los que se lavó con agua corriente después de cada intervención y luego se lo hizo con acetona a fin de eliminar toda posibilidad de sobre-dosificación en el pulverisaje habiendo observado el depósito homogéneo en los cartones del insecticida determinando así la máxima exactitud de los resultados y el máximo rendimiento técnico de los experimentos realizados.

Acción del rothane (DDD o TDE)

Adulticida

En la especie *Aëdes camposanus* la acción mortífera se observa desde la dilución del 0.5% se hace total desde la dilución de 2.5% siendo pues la primera dilución de mortalidad mínima y la otra la dilución de mortalidad máxima.

En la especie *Culex quinquefasciatus,* la acción mortífera se observa desde la dilución del 1% siendo completa en la dilución 2% siendo pues la dilución de mortalidad mínima la primera y la dilución de mortalidad máxima la segunda para esta especie.

Larvicida

Los experimentos indican que la cantidad mínima letal para las larvas de *Aëdes camposanus* Dyar es la dilución al 0.5% en concentración de 10:000 partes a una y la máxima cantidad letal es 2.5% en concentración de 10:000 partes a una. En la especie *Culex quinquefasciatus* Say la dilución 0.5% continua siendo la cantidad mínima letal en concentración de 1.10.000 y la cantidad máxima letal es la dilución 4% en concentración 1.10.000.

El larvicida ataca a las larvas produciéndoles en los primeros momentos una gran exitación que es la forma como se inicia la intoxicación y se observa que estas comienzan a subir y bajar apresuradamente, moviéndose muy anormalmente;posteriormente los movimientos se hacen mas lentos y viene como climax la paralización total de la larva, la que se hunde ahogándose por no poder seguir obteniendo aire para sus procesos de metabolismo y se observa que queda inmovil en el fondo del recipiente, mientras aumenta la dilución y a la mayor concentración (1:10.000) las larvas mueren mas rapidamente siendo el TDE (Rothane) un larvicida ideal y de una gran efectividad la que viene a ser corroborada por nuestra serie de experiencias realizadas sobre especies comunes del Ecuador.

Acción del gammexane (hexaclorobenzeno)

Adulticida

Este insecicida es un poderoso anti-alado de contacto remanente. En las experiencias realizadas se observó que en ambas especies la mínima dosis letal era entre 0.5 y 1.5; desde entonces la acción letal era completa y absolutamente uniforme al través de las 6, las 12, 24 y 48 horas. Generalmente los primeros síntomas de intoxicación se observaban entre las tres y cuatro horas por un período de exitación muy notable, seguido de una laxitud y parálisis, la que venía seguida de la muerte del insecto el cual quedaba en el fondo de la cajita en donde se lo recogía. Se observada al microscopio adherencias de polvito blanco especialmente en los púlvulos de las patas los que possiblemente eran cristalitos de hexaclorobenzeno que se habían adherido a los pelitos de las patas. La acción letal viene dada por el contacto directo con la quitina del tejido básico del insecto.

Larvicida

El „Gammexane" como insecticida y larvicida es de una gran efectividad; especialmente como larvicida es de una efectividad brutal, pues desde el porcentage de 0.5% en sus respectivas duliciones produce entre las dos y seis horas muertes entre un 60% en *Aëdes camposanus* Dyar y un 40% en *Culex quinquefascitus* Say. Este último mosquito es muy dificil de matar con diluciones de concentración muy debil, sin embargo a partir del 2% en adelante en cualquiera de las concentraciones se observan un 100% de muertes dentro de las 6 horas determinadas por la alta toxicidad del insecticida, siendo uno de los larvicidas ideales. Sin embargo su límite de acción no va mas allá de los 10 a 15 días en condiciones de laboratorio, siendo este corto tiempo de acción una limitación a su uso en efecto remanente como larvicida de contacto. No tiene ninguna acción sobre los huevos y es muy mínima la acción sobre las pupas, por lo tanto son estas partes del ciclo vital que escapan a la efectividad del larvicida, sin embargo en este caso especial solo se investigaron larvas en cuarto estadio de las especies que servieron de testigos, y solo incidentalmente se adicionaron huevos y pupas para observar opcionalmente la acción sobre estos del insecticida, no teniendo importancia para las investigaciones realizadas.

El "Gammexane" es muy recomendable por su alto poder adulticida y larvicida siendo uno de los compuestos de mas estabilidad y acción mas efectiva.

Acción del diclorodifeniltricloroetano (DDT)

Adulticida

Este insecticida es notable por sus efectos pues en concentraciones de solo 0.5% produce hasta un 50% de muertes y en las concentraciones superiores al 2% se observa siempre un 100% de muertes, por el contacto en ambas especies al cabo de solo 6 horas de exposición al insecticida, determinando la muerte de todo el lote expuesto sin excepciones de ninguna clase.

Larvicida

El diclorodifeniltricloroetano tiene una acción larvicida notable, aún en las mínimas diluciones produciendo una intoxicación violenta en la larva, posiblemente por introducirse al través de la quitina y en suspensión acuosa puede también ser ingerido por la larva entre sus alimentos. El hecho es que antes de las tres horas y a cualquiera de las diluciones experimentadas y con ambas especies se observaban a las larvas en estado avanzado de intoxicación, descendiendo hacia el fondo del vaso de cartón, quedando allí inmóviles ya sea por la paralización y posteriormente por la muerte.

Conclusiones

1o. El objeto principal en una evaluación comparativa de la efectividad y acción insecticida de varios insecticidas, tomando como testigos comparativos a dos especies de mosquitos costeros ecuatorianos, es estudiar la forma en que estos actuan frente a los insecticidas en su estado de alado o adultó y en su estado primario o larvario.

2o. Los insecticidas usados: Rothane (TDE), Gammexane y Diclorodifeniltricloroetano (DDT) son muy efectivos como insecticidas de contacto contra las dos especies ensayadas *Aëdes camposanus* Dyar y *Culex quinquefasciatus* Say. En su forma larvaria estos mosquitos son muy sensibles a la acción tóxica de los insecticidas en forma de emulsión, observándose en las distintas diluciones una marcada mortalidad ya observada también anteriormente por varios observadores, más jamás en la forma sistemática como se han llevado a efecto estas experiencias, buzcando la menor y mayor dilución tóxica, determinando así la acción tóxica de contacto del respectivo insecticida estudiado.

EXPERIENCES OF AN ARMY-ENTOMOLOGIST

by
Paul Peter BABIY
Salzburg, Austria

When during the last war the necessity arose to prevent the spread of Malaria among the German troops operating at the Southern and Southeastern region of the different theatres of war, the position of an "Army-Entomologist" was created.

Even among Germans this fact is very little known and probably even less so in other countries.

So it may be interesting enough to put down the experiences of one, who has served in this capacity, not in a central Institute, but in the field, where the practical work had to be done.

It started for me quite accidentally, when I met an old acquaintance that I had made during an expedition to Surinam in 1927. I had gone down there at that time with my collegue Dr. W.T.M.FORBES from Cornell University to clear up certain questions, which had arisen from the plates of Maria Sibylla MERIAN's famous work: "Die Verwandlung der Insekten von Suriname". Dr. PETER was then the doctor of the Bauxite Mining Camp at Moengo, a position to which he as an expert on Malaria was especially well fitted.

By his suggestion I was requested by Professor MARTINI from Hamburg, to devote myself to this special field of activity.

First of all I took part in a course at the "Tropenmedizinisches Institut" of the "Militärärztliche Akademie" at Berlin, where we were introduced into the special field of preventative methods against Malaria and other insect-transmitted diseases as Tularemia, trenchfever and so on.

The medical men among us were initiated into the entomological side of the questions involved, while we biologists – I was one of the very few entomologists by profession amongst them – were made familiar with the medical aspects.

For me it was one more experience to prove, how strongly specialised we biologists are, and how ignorant we become in other fields of biology outside of our own. The split between Zoology and Entomology grows deeper and deeper apparently, to the detriment of both.

After an introduction into practical fieldwork in Macedonia I was called to the East. The Ukraine was destined to be my first field of action.

I had a thorough discussion of the work to be done with the medical men in charge and the commanding general, who both showed eager interest in my work. After that I started on an extensive journey by car through the waste territories involved, to get a first hand idea of prevailing conditions.

I visited the different places and made many field investigations of swamps, ponds and pools as well as houses and stables. In many cases it

was possible to furnish redress of dangerous conditions by advising a shifting of quarters and strict preventative measures as approved by us and too well known, to go into in detail here. Informative lectures were held also for the troops, and questions in the discussion afterwards encouraged.

On the whole it can be said, that the Ukraine is not greatly endangered by Malaria.

There were Soviet-reports known to us, which spoke of repeated wholesale epidemies of Malaria in the Ukraine even so far North as Kiev, in the past. Such an outbreak would have been disastrous to the troops passing through the territory to the front and back on the way home.

There was no outbreak during the occupation, neither among troops nor the civilian population.

In my many contacts and talks with local civilians, who were actively engaged at the local Malaria-Points and Stations as organized by the Soviets – those men and women were continuing their work as usual – I found the prevailing opinion, that Malaria was much farther spread in the territory than the actual findings by us showed it to be. Then I came to a place, where the local entomologist in charge had about the same idea as we had and this man put the blame for these discrepancies onto his laboratory workers, who made the microscopical diagnoses. He suspected about 10-25% too many positive findings reported. Our suggestion to do the diagnosing work himself, he absolutely refused to even consider, as he – as he put it – was an "entomologist only".

It is quite typical, as far as my experiences go, to find in those regions people, who are more or less well trained for a very limited field of investigation only, without any ability to judge its value. Poor training and eagerness on the side of the laboratory staff to overemphasize their own importance, was blamed for the incorrect results by the local entomologist in charge.

A check of the microscopical slides in question by our own experts showed more than 50% of so called positive cases as being negative.

During the winter I kept in close touch with the Institute of Hygiene in Kiev and followed up all reports or rumours on cases of Malaria. The more you investigated the thinner grew the rumour, ending practically always in a flat denial.

To summarize my impressions on this territory:

The Ukraine is a potential region of Malaria only in its Southern half and there only in the swampy lowlands of the rivers. Perpetual infiltration of people from the East suffering from Malaria has created local Malaria reservoirs, but of the tertian kind only. There is no endemic infestation with Malaria tropica and Soviet-reports showed clearly, how groups of people from the Caucasus and Turkestan, infected with tropical Malaria, were not able to create any havock here among the healthy local population. The cases became fewer and fewer and gradually faded out of the picture.

My next experience in the field was in Sardinia. Here it was necessary to deal with very serious conditions. The entire island, so interesting and picturesque in many places with its high mountains and nuragi, is thoroughly infested with Malaria of all kinds, even the pernicious kind being prevalent and the population suffers considerably. 1943 happened to be a very dry year for the island as the spring rain had failed to materialize. The olivetrees flowered but bore no fruit. There was very little water anywhere and most of the land showed a brown and deadly dry face in early summer already. The rare green patches, visible from far off, were the only places that had to be investigated, as only there water was on, or near the surface. You could easily spot every spring, any creekbed – there were always bushes of red flowering oleander typical for them – and any swamp in that region.

Unfortunately military necessities and sometimes shortsightedness brought on, that troop-units were placed in very unhealthy locations before I was informed of such a move, and all atebrine-prophylaxis could not prevent a heavy casualty list.

In one case a unit was especially unfortunately located; but military necessities, at least as understood by its commander, prevented a relocation, notwithstanding all my remonstrances.

With an atebrine prophylaxis very carefully applied, the turnover of men was just enough, so as to enable the unit to keep its position against a possible airlanding. There were many men from the city of Hamburg in that unit. One day news came of the heavy air bombardment of this city and bad news, or worse –, no news from home for many. Downheartedness, like a shock, got hold of the men, helped along by the loss of one of their best, who succumbed to an attack of pernicious Malaria twelve hours after the very first attack of fever. Now – Malaria spread like wildfire, ultimately forcing the unit to be replaced by others, as the fighting strength had gone down to about 10 % of the men.

From now on considerably more weight was put on my suggestions and each relocation had to be made known to me well in advance, soliciting my opinion about the Malaria-situation there.

Small projects around trooplocations were cleaned up by the units themselves according to my directions. As I could not be at all the places at one time, a small force, trained by myself in such fieldwork, was placed with the unit concerned and did remarkably well. Another group, located with me, was trained in preparing microscopical slides from the bloodspecimens sent in from the different units, and diagnosed them carefully. These were medical students, who had not had a chance yet to start their formal studies at a medical school, but by experience had become seasoned diagnosticians, to whom the military doctors, not so well trained in this delicate work, turned for information. Our mobile laboratory always was a busy place and often visited by many, also the local Italian, or better said Sardinian doctors.

Anopheles superpictus Grassi was nowhere met with in the mountains of

the island, neither adults nor larvae, though a special point was made of being on the lookout for them.

My experiences as an Army Entomologist may be summarized as follows: The institution of Army Entomologists has proved its value beyond doubt.

Prevention of Malaria infection was tried by careful location of troop-units and the cleaning up of smaller creeks or swampy places around such locations. Atebrine prophylaxis proved its value, but has to be aided by good nourishment and high spirits, to give the individual full resistance against the outbreak of the infection already acquired. There seem to be possible consequences in a long drawn out prophylactic use of atebrine in the form of considerable fatigue. My suggestion to investigate this matter, was roughly brushed aside in Berlin. In about a quarter of a million cases I heard of only two men, who had trouble in taking the drug, getting violantly sick each time about two hours after swallowing the pills.

To be successful in the position of an Army Entomologist you have to be more than just a scientist. You have to stand your ground against energetic men (as military commanders have to be by profession) and see to it that your points get the necessary attention. So psychology should not be neglected if you want practical results and really to help your fellow-men with your knowledge and experience.

DISCUSSION

Mr. **Busvine** remarks that malaria in Sardinia has been greatly reduced at present.

Mr. **Babiy** agrees, and adds that the river Mogoro was the main trouble to the Germans.

Mr. **Buxton** confirms the speaker's statement that *A. superpictus* is absent in Sardinia. His findings point to a considerable reduction in malaria.

Mr. **Theodor** asks (1) what was the main carrier in the Ukraine; (2) whether *A. sacharovi* was found there.

Mr. **Babiy** replies to (1): all members of the *maculipennis*-complex; to (2): *A. sacharovi* was not recorded.

Mr. **Swellengrebel**, referring to records of falciparum malaria in the far North of Russia, suggests as an explanation either importation or erroneous identification of the parasites detected.

Mr. **Babiy** considers both explanations as likely to be correct.

PIQURES D'INSECTES VENIMEUX

par
Marcel LECLERCQ
Beyne-Hensay (Liége), Belgique

Cette communication est consacrée uniquement aux insectes venimeux piqueurs *(Hyménoptères Aculéates)*; nous ne parlerons donc pas des insectes venimeux urticants ou vésicants. C'est le résumé de recherches que nous avons effectuées seul ou en collaboration au cours des dernières années (M.LECLERCQ, 1949; 1950; M.LECLERCQ, P.FISCHER et J.LECOMTE, 1949).

I. – Accidents produits chez l'homme

1. **Cas bénins:** simple tuméfaction locale avec douleur aiguë et urticaire peu accusé, parfois léger mouvement fébrile.

2. **Cas moyens:** *forme syncopale* avec vertiges, nausées, céphalalgie insupportable, palpitations et *urticaire* important, voire généralisé. Cette forme syncopale peut aussi s'accompagner de phénomènes allergiques au niveau de certains viscères: *dyspnée asthmatiforme* (H.REED, 1946); *sténose pylorique* provenant d'un oedème gastrique fugace constaté par gastroscopie chez un apiculteur particulièrement sensible (R.CHEVALIER, 1925).

3. **Cas mortels:** La mort peut être causée par:

a. *choc anaphylactique*, suite à une piqûre dans une veinule ou une artériole superficielle chez une personne sensibilisée. La littérature internationale abonde en cas de ce genre. En Belgique, nous en avons signalé deux après piqûres de guêpes:
le premier chez une femme piquée au niveau d'une veine du bras; immédiatement après, phénomènes d'asphyxie, écume à la bouche, hypotonie, émission d'urines et de selles, aucune réaction cutanée urticarienne, exitus en moins d'une demi-heure.
le deuxième, analogue au précédent avec exitus deux heures après la piqûre.

b. *asphyxie*, suite à une piqûre au niveau des muqueuses buccales ou pharyngées d'où oedème sténosant de la gorge.

c. *envenimation multiple.* H.HUGUENIN (1927) relate un cas par piqûres multiples de guêpes chez un robuste bûcheron qui eut le malheur de déranger un nid pendant son travail; la mort survint 5 à 15 minutes après l'envenimation.

II. – Principes toxiques et Physiopathologie des Venins

Chez les *Fourmis*, on admet que le principe toxique est l'acide formique; mais cette donnée est insuffisante (R.STUMPER, 1950).

Chez les autres *Hyménoptères Aculéates*, et en particulier le venin d'abeille, on a identifié jusqu'à présent de l'*histamine*, un polypeptide: l'*apitoxine* et de la *riboflavine*.

Plusieurs propriétés du venin d'abeille ont été mises en évidence:

a. *action hémolytique*

b. *diminution de la coagulabilité du sang* par la diminution de la thromboplastine plaquettaire (G.TUDORANU, A.ROSIN, M.GHEORGHIU et C.RAUT, 1948).

c. *modifications humorales:* glycémie, clorurémie, calcémie.

d. *modifications des cholestérines de la cellule.*

e. *action bactéricide* sur le staphylocoque, streptocoque, colibacille.

f. *effets dus à l'histamine:* la quantité d'histamine présente dans le venin est nettement insufisante pour permettre d'expliquer à elle seule tous les effets toxiques du venin.

g. *pouvoir toxique de l'apitoxine,* protide agissant comme une protéase. Elle est responsable des réactions allergiques traduisant un état intermédiaire entre l'immunité totale et la sensibilité totale. Chez les apiculteurs, la sensibilité est fort variable; certains n'arrivent jamais à obtenir une immunité satisfaisante et doivent parfois cesser leur métier.

Il a été aussi démontré par FELDBERG et KELLAWAY (1937), que le venin d'abeilles provoque une importante libération d'histamine sur des poumons et des foies perfusés du cobaye et du chien. Or vous savez que l'histamine, présente dans tous les tissues de l'organisme, provoque la contraction des muscles lisses et la vasodilatation des capillaires avec augmentation de leur perméabilité d'où hémorragie à ce niveau.

Le résultat de ces recherches expérimentales et une meilleure compréhension du choc anaphylactique permettent de mieux comprendre les accidents graves consécutifs aux piqûres d'Hyménoptères.

Vous savez qu'une réaction anaphylactique est une des expressions de la réaction antigène-anticorps. Elle se produit uniquement chez l'animal sensibilisé à une substance étrangère par une atteinte préalable.

Les accidents sont locaux ou généraux suivant que l'on pratique l'injection déchainante sous la peau ou dans le sang circulant.

Il y a au moins deux substances libérées pendant le choc anaphylactique: l'*histamine* et l'*héparine.* Ces deux substances sont libérées des tissus par l'action d'une protéase apparaissant lors du déclenchement du choc. L'histamine ainsi libérée en grosses quantités va ainsi produire un véritable suicide de l'organisme en contracturant les muscles lisses, d'où asphyxie par spasme bronchique, hypotension par paralysie vasomotrice périphérique et hémorragie au niveau des capillaires, émission d'urines et de selles....

Quant à l'héparine, elle est responsable de l'incoagulabilité du sang anaphylactique.

Dans le cas d'envenimation multiple, la mort est probablement due au même mécanisme de libération massive d'histamine provoquée par la quantité de venin injecté. Ce qui semble confirmer cette opinion, c'est que les autopsies des cas mortels ont montré avant tout des hémorragies au niveau des capillaires avec hyperémie des organes internes.

Dans des cas graves, mais non mortels, on a noté aussi des complications

qui sont certainement tributaires de lésions hémorragiques: *hémiplégie droite avec aphasie* chez un apiculteur (M.ROCH, 1948) et *hémoglobinurie* après piqûres multiples d'abeilles (M.F.KOSZALKA, 1949).

La mort peut survenir rapidement après l'envenimation (quelques minutes et plus) ou tardivement (quelques jours). Cette latitude peut s'expliquer par différents facteurs: *hypersensibilité congénitale, hypersensibilité acquise, localisation de la piqûre, nombre de piqûres et quantité de venin injecté,* enfin l'*espèce d'Hyménoptère piqueur et la qualité du venin.*

h. propriété thioloprive, que nous avons mise en évidence avec P.FISCHER et J.LECOMTE (1949). A côté de leur teneur en histamine, de leur pouvoir allergisant, de leur activité protéolytique et protétoxique, les venins de guêpe et d'abeille possèdent aussi les propriétés des corps vésicants et lacrymogènes (gaz de combat: ypérite, léwisite, etc.)

En effet:

1. ils bloquent les groupes SH de la cystéine *(test au nitroprussiate de soude en milieu ammoniacal)* les transformant en liaison – S-S –;
2. ils provoquent l'effet LUNDSGAARD sur le muscle strié de grenouille *(contracture et inexcitabilité progressive après travail, dues au blocage du métabolisme des Hydrates de Carbone, d'où accumulation d'acide lactique dans le muscle);*
3. ils ont une action lacrymogène en instillation dans le cul de sac conjonctival du lapin *(afflux lacrymal, chémosis* et *ectropion).*

On peut donc comprendre maintenant pourquoi le glutathion réduit, le thiolactate de sodium possède vis à vis du venin d'abeille un certain pouvoir détoxicant, comme l'avait montré L.BINET, et M.BURSTEIN (1939) et L. BINET, G.WELLER et E.ROBILLARD (1939). En réagissant avec les corps thioloprives du venin, ils l'empêchent de réagir avec le protoplasme des cellules atteintes. Ce mécanisme est tout à fait comparable à l'action antiléwisite du B.A.L.

III. – Thérapeutique des Accidents

Un grand progrès a été réalisé dans le traitement des piqûres d'insectes avec les *antihistaminiques.*

Pour les accidents locaux, l'application immédiate d'onguent avec antihistaminique est rapidement suivie d'une sédation complète.

Pour les cas moyens, il est nécessaire d'administrer le produit en intramusculaire ou intraveineuse ou bien per os.

Pour les cas plus graves, le traitement est celui du choc anaphylactique: calcium, antihistaminique, analeptique cardio-respiratoire, sympathicomimétique, hémostatique.

Pour terminer, je voudrais souligner que les anciennes thérapeutiques des piqûres d'insectes, dont la multiplicité démontre l'inefficacité, doivent être remplacées par le traitement aux antihistaminiques (onguent, comprimés ou ampoules injectables) plus efficaces et plus rationnelles, comme nous l'avons constaté nous-même ainsi que d'autres auteurs (W.T.STRAUSS, 1949; M.A. TZANCK, 1949; P.TAMINE, 1949).

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DISCUSSION

Mr. **Van Thiel** asks which emergency measures to take in the absence of a medical man.

Mr. **Leclercq** replies that in non-peracute cases antihistaminic unguents are useful and can be applied by anyone.

Mr. **Galliard** asks if, besides immunisation, sensibilisation also occurs.

Mr. **Leclercq** replies that immunisation is the rule, anaphylaxia the exception, occurring only in the case of very rapid absorption.

Mr. **Simic** refers to the effect of bites of *Simulium columbaczense*, but the Chairman interferes saying that the discussion should be limited to venomous *Hymenoptera*.

MYIASES HUMAINES OBSERVEES EN BELGIQUE

par
Marcel LECLERCQ
Beyne-Hensay (Liége), Belgique

On appelle *„myiase"* les syndromes divers produits par des larves de Diptères vivant dans le corps de l'homme ou des animaux. Bien que ces affections soient assez rares chez l'homme dans nos régions, plusieurs cas, présentant même une certaine gravité, ont été observés récemment en Belgique.

Du point de vue éthologique, on classe les Diptères causant des myiases en trois groupes:

1. **Mouches dont les larves sont productrices de myiases spécifiques:** ce sont des *parasites obligatoires*, leurs larves se développent exclusivement dans la chair vivante.
2. **Mouches dont les larves sont productrices de myiases semi-spécifiques:** ce sont des *parasites occasionnels*, leurs larves se développent habituellement dans des substances organiques en décomposition.
3. **Mouches dont les larves sont productrices de myiases accidentelles:** ce sont des *parasites accidentels*, leurs oeufs ou jeunes larves pouvant être ingérés passivement avec des aliments ou des boissons avariées.

Du point de vue clinique, on classe les myiases suivant la localisation des larves:

1. **Myiases cutanées** dont il y a plusieurs variétés: *furonculeuse, rampante, à tumeurs ambulatoires, myiase des plaies* et *myiase cutanée purement externe.*
2. **Myiases cavitaires:** larves dans les sinus, naso-pharynx, yeux, conduit auditif.
3. **Myiases organiques:** larves dans le tube digestif ou l'appareil uro-génital.

Voici maintenant les cas qui ont été observés jusqu'à présent en Belgique

1. **Myiases cutanées:**

a. *Myiase furonculeuse à larves d'Hypoderma* (A.SPRING, 1861).

b. *Myiase des plaies* (M.LECLERCQ, 1948): au niveau du gros orteil chez un homme et a la face interne de la jambe chez une femme (Larves de Diptères non identifiés).

c. *Myiase cutanée purement externe à larves de Lucilia* (M.LECLERCQ, 1948): chez un homme présentant un état eczémateux généralisé. Plusieurs larves de *Lucilia* se trouvaient dans les espaces interdigitaux des orteils: elles vivaient en surface dans les suintements et croûtes abondantes et non dans une plaie.

2. **Myiases cavitaires:**

a. *Ophthalmomyiase interne antérieure, secondaire, à larve d'Hypoderma (1ier stade larvaire)* (M.LECLERCQ, 1949): chez un enfant de 17 mois, la larve se trouvait dans la chambre antérieure de l'oeil droit. D'après ce qu'on

connaît de la biologie des *Hypoderma,* parasites réguliers des Bovidés, la mouche adulte a dû pondre sur l'enfant probablement vers juillet-août 1943: la jeune larve aura pénétré dans la peau puis aura entrepris les migrations connues pour arriver finalement au niveau de l'oeil par une voie indirecte en février 1944. L'enfant a perdu complètement la vue de cet oeil.

3. **Myiases organiques:**

A. *Myiases intestinales:*

a. à larves d'Anthomyia chez une femme (FRANÇOIS, 1861).

b. à larves de Musca domestica L. (M.GOETGHEBUER, 1924):
chez un enfant d'1½ an présentant des symptômes d'entérite. Au douzième jour de l'affection, expulsion de 14 larves. Il est intéressant de souligner que cette observation a été faite à la mi-décembre à un moment où on ne trouve plus guère de larves de mouches.

c. à larves de Muscina stabulans Fallen (M.GOETGHEBUER, 1924):
Dans ce cas, on trouva non pas des larves, mais des pupes dans les selles du malade. Ces pupes ont donné au bout de deux jours les mouches adultes qui étaient de taille très réduite.

d. à larves de Fannia scalaris Fabricius *et Teichomyza fusca* Macquart (M.GOETGHEBUER, 1928):
Ce cas est particulièrement curieux. Il concerne une femme qui élimina pendant très longtemps des larves et des oeufs dans ses selles. Le Dr GOETGHEBUER admit l'éventualité d'une pédogenèse, l'oeuf arrivant à maturité dans le corps de la larve et étant pondu par celle-ci. Le développement des oeufs et des larves se faisait donc dans le milieu intestinal sans passer par le stade de pupe ou d'imago.

e. à larves d'Eristales (L.VAN DEN BERGHE et J.BONE, 1944):
chez un homme qui élimina dans ses selles plus de 40 larves le premier jour et 10 à 30 chacun des six jours suivants.

Un autre cas a été observé chez un homme qui se plaignait de douleurs à l'épigastre depuis deux mois, avec d'autres malaises. L'administration de quelques capsules d'extrait de fougère mâle avec calomel provoqua l'élimination de larves d'*Eristales* dans ses selles (J.MULLER, 1946).

Les myiases intestinales à larves d'Eristales sont probablement les plus fréquentes dans nos régions, et tous les cas ne sont pas toujours signalés. L'espèce la plus commune, *Eristalomyia tenax* L., vole de mars à octobre. Elle dépose ses oeufs dans toutes les eaux sales, les eaux croupissantes des fossés, des étangs, dans les latrines, les fosses à purin; mais on peut aussi trouver des stades larvaires dans des eaux relativement propres, sources de contamination. Les larves peuvent vivre dans le tractus gastro-intestinal et continuer normalement leur évolution (G.CHAGNON et M.LECLERCQ, 1949).

B. *Myiases des voies urinaires:*

a. à larves de Musca domestica L. (E. d'HAENENS, 1898):
dans l'urètre d'un jeune homme avec antécédents blennorragiques.

b. à larves de Calliphora (M.LECLERCQ, 1949):
C'est le premier cas de myiase des voies urinaires par *Calliphora* observé

dans le monde. Il s'agissait d'un malade de 62 ans, soigné par le Dr CUYPERS (Neerpelt), atteint depuis des années de paraplégie spastique et de troubles intestinaux. Ceux-ci, ainsi que son infirmité, provoquaient des séances fréquentes et prolongées au W.C., situé tout près de la procherie. Le 18 septembre 1949, le patient élimina avec son urine plusieurs larves de *Calliphora*. J'ai mis en évidence la présence de sang dans le contenu du tractus digestif de ces larves qui étaient arrivées à maturité.

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DISCUSSION

Mr. **Simič** recalls a case of myiasis of the tongue in Kosovo (Yugoslavia).

Mr. **Buxton** holds that *Lucilia* larvae staying on the surface of the skin (between the toes) must be a rare occurrence.

Mr. **Theodor** saw this kind of superficial myiasis in dogs, caused, however, by larvae of *Wohlfartia*.

He was astonished to hear of internal ophthalmomyiasis caused by *Hypoderma*.

Mr. **Leclercq** agrees that internal ophthalmomyiasis caused by *Hypoderma* is rare, but external ophthalmomyiasis caused by these larvae is not rare.

Mrs FELDMANN-MUHSAM mentions a case of *Lucilia* myiasis.

APPLICATION DE L'ENTOMOLOGIE A LA MEDECINE LEGALE

par

Marcel LECLERCQ

Beyne-Hensay (Liége), Belgique

J'ai publié en 1949 un exposé détaillé de la question. On sait depuis les travaux de MÉGNIN que les insectes nécrophages apparaissent sur les cadavres en escouades successives. Pour la faune des cadavres à l'air libre, aux latitudes tempérées, on a reconnu les escouades suivantes:

Première escouade: *Calliphora, Musca, Muscina.*

Deuxième escouade: *Sarcophaga, Lucilia, Cynomyia.*

Troisième escouade: *Dermestes, Aglossa.*

Quatrième escouade: *Piophila, Fannia,* Corynètes, Drosophiles, Sepsides, Sphaerocerides, Eristales, *Teichomyza fusca* et *Madiza glabra.*

Cinquième escouade: *Ophyra,* Phorides, et les Thyréophorides.

Sixième escouade: Acariens.

Septième escouade: *Attagenus, Anthrenus, Dermestes, Aglossa, Tineola, Tinea* et *Monopis.*

Huitième escouade: *Ptinus* et *Tenebrio.*

Il est bien clair que ces escouades se succèdent en fonction des modifications biochimiques des tissus. Mais il y aurait lieu de préciser au cours de recherches ultérieures certains détails relatifs à la composition de chaque escouade en rapport avec les conditions écologiques et saisonnières.

Ce qui est connu actuellement est néanmoins suffisant pour que l'on puisse dans bon nombre de cas, tirer des conclusions quant à la date de la mort d'un individu dont on trouve le cadavre. Cette méthode est d'ailleurs la seule utilisable lorsqu'il s'agit de cadavres trouvés dans un état de putréfaction avancée.

M. le Professeur P.MOUREAU et Dr L.QUINET du service de Médecine Légale de l'Université de Liége m'ont soumis au cours des dernières années toute une série de cas. Nous donnerons quelques exemples:

1. Cadavre d'enfant découvert à St. Hubert (Ardennes Belges)

En mai 1947, on découvrit le cadavre d'un enfant derrière un fourneau dans une ferme de St. Hubert. La putréfaction était tellement avancée qu'il était très difficile de donner une estimation précise sur la date de la mort. Le cadavre était entouré d'un linge dans lequel circulaient au moment de la découverte, de nombreuses larves de *Calliphora* en fin de croissance; on trouva également une femelle morte de *Calliphora erythrocephala* (la femelle qui périt après sa ponte!), une pupe toute récente de la même espèce et quelques pupes de *Phorides.*

Les larves qui nous ont été remises le 21 mai, produisirent toutes leurs pupes du 21 mai au soir au 22 mai. Les adultes sortirent à partir du 2 juin, soit une dizaine de jours après la pupaison.

Antérieurement, nous avions effectué de nombreux élevages de *Calliphora erythrocephala* et nous avons pu déterminer avec la plus grande précision qu'au cours des mois de printemps, aux conditions thermiques d'une pièce d'intétieur légèrement chauffée, où la température n'a jamais dépassé 20° C. et en bonnes conditions de nourriture sur du fromage gras, le développement d'une ponte de *Calliphora,* à partir du jour de la ponte jusqu'à la formation des premières pupes, réclame de 19 à 20 jours. (J. et M.LECLERCQ, 1948).

Les larves de *Calliphora* qui nous furent soumises durent se développer dans des conditions fort comparables; aussi, nous avons admis comme forte présomption que les pontes ont été effectuées sur le cadavre une vingtaine de jours avant le 21 mai, soit vers le premier mai 1947.

D'autre part, connaissant l'habileté des femelles de *Calliphora* a déceler l'odeur de la chair qui commence à se décomposer, nous avons pensé qu'il n'aura certainement fallu que quelques jours pour que la première mouche bleue vienne y déposer ses oeufs.

Enfin, il s'agissait bien de la première génération de *Calliphora,* car toute génération antérieure aurait laissé des traces telles que des pupes vides sous le cadavre ou dans le linge.

Nous avons donc émis l'hypothèse que le cadavre fut déposé au cours de la dernière semaine d'avril, peu après le meurtre de l'enfant.

L'enquête judiciaire a suivi son cours et la coupable fut arrêtée peu de temps après: ses déclarations et aveux ont confirmé entièrement les conclusions de notre rapport.

2. Cadavre de femme découvert à Liége

Le 13 juin 1950 vers 14 heures, nous avons examiné des larves de *Calliphora erythrocephala,* trouvées sur le cadavre d'une femme dans une habitation de Liége; la putréfaction était très marquée. Certaines larves mesuraient 5–6 mm, ce qui correspond à un développement de 3 jours dans les conditions optimales; d'autres mesuraient 10–12 mm, ce qui correspond à un développement de 5 jours (D.SCHANZ, 1934).

Etant donné la température particulièrement favorable du moment, nous avons pensé que les pontes ont dû être effectuées très rapidement sur le cadavre, et endéans quelques heures.

Nous avons donc conclu que la mort de cette femme remontait de cinq à six jours à partir du moment de notre examen.

Ce délai a encore été confirmé par l'enquête judiciaire.

Ces deux exemples sont assez démonstratifs, mais pour arriver à de tels résultats, l'entomologiste doit avoir tous les renseignements sur l'état du cadavre, l'endroit de dépôt, les conditions climatiques, et bien entendu l'enquête entomologique doit être faite avec soin.

Le matériel doit aussi être récolté de telle façon que l'élevage des stades larvaires puisse encore être tenté, pour préciser l'identification de l'espèce et son état de développement.

Pour terminer, nous soulignerons que de nouvelles recherches sur la durée de développement des insectes nécrophages, l'identification des stades larvaires et leur biologie, seraient d'une grande utilité pour préciser les données de l'Entomologie et Médecine Légale.

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DISCUSSION

Mr. **Reid** considers Leclercq's observations of great importance. In Malaya speaker was sometimes asked to identify maggots from human corpses and to say if he could fix the probable time of death. Usually he found this impossible because his knowledge of the life cycle of the flies, in the majority of cases *Chrysomyia megacephala*, was insufficient; moreover, he did not know whether the maggots were 1st, 2nd, 3rd generation or later.

ERGEBNISSE DER KOMMUNAL GELENKTEN WANZENBEKÄMPFUNG IN BERLIN

von

H. KEMPER

Berlin-Dahlem, Deutschland

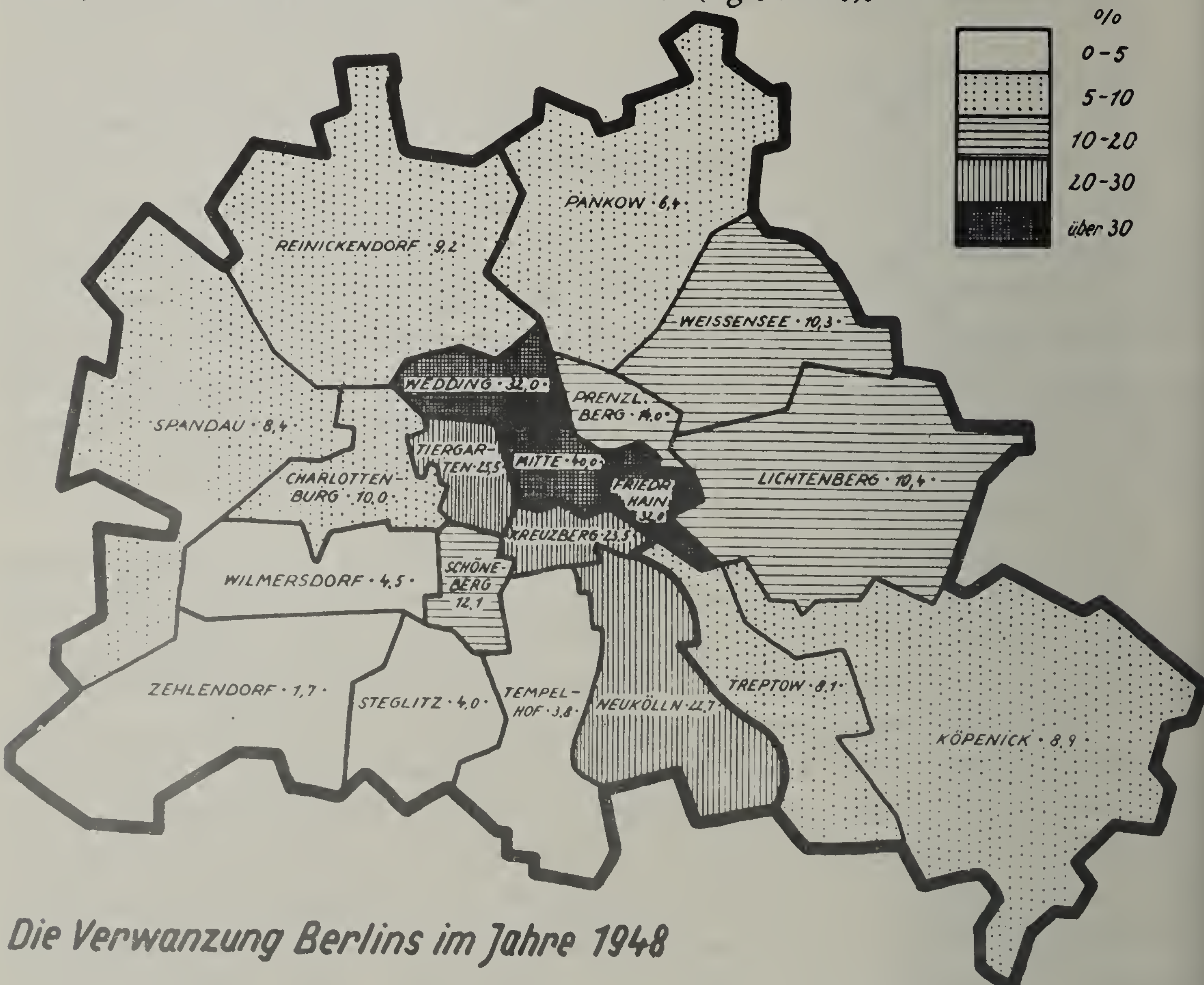
Die Wanzenplage wird sich wohl nicht endgültig beheben lassen, wenn man die Bekämpfung nur der Initiative der Wohnungsinhaber und Hausbesitzer überlässt. Das hat verschiedene Gründe: Die Wanze kann leicht von Wohnung zu Wohnung gelangen, und niemand vermag sich daher mit Sicherheit vor ihrem Zudringen zu schützen. Sie wird wegen ihrer versteckten Lebensweise meistens nicht sofort, sondern erst dann entdeckt wenn sie sich schon eingenistet und stärker vermehrt hat. Manche Menschen unterlassen es, wirksam gegen sie vorzugehen, weil sie aus „einer falschen Scham" heraus das Vorhandensein des „Ungeziefers", um jeden Preis geheimhalten wollen, oder weil es ihnen an Ordnungssinn und Sauberkeitsgefühl mangelt, oder auch, weil ihnen das Geld für durchgreifende Gegenmassnahmen fehlt.

In der Vergangenheit wurden wirklich durchgreifende Wanzenbekämpfungen hauptsächlich in den Wohnungen besser gestellter Kreise durchgeführt. Die meisten sehr dicht belegten „Armeleute-Wohnungen" aber blieben verwanzt und bildeten den Ausgangsherd für immer erneuten Befall anderer Wohnungen.

Die Berliner Gesundheitsverwaltung entschloss sich nach dem Kriege planmässig gegen die Plage vorzugehen. Zunächst erschien es uns notwendig, durch eine statistische Erhebung auf breiter Basis festzustellen, wie stark die Verwanzung tatsächlich war und wie sie sich auf die einzelnen Wohnviertel und auf die einzelnen Kategorien der Wohnungen verteilte. Diese Untersuchung erfolgte im Sommer 1948 in der Weise, dass durch besonders geeignete Hilfskräfte die Inhaber aller Wohnungen jedes fünften Hauses, sowie sämtliche öffentlichen Gebäude (Krankenhäuser, Alters- und Flüchtlingsheime, Hotels, Pensionen, Schulen, Gefängnisse, Theater, Polizei- und Feuerwachen) mündlich befragt wurden. Aehnliches ist m.W. bisher in keiner anderen Stadt durchgeführt worden. Ueber die Ergebnisse dieser Untersuchung, die interessant und z.T. überraschend waren, habe ich in der „Ztschr. f. hyg. Zool." (H. 6, 1949) genauer berichtet. Einiges sei hier wiederholend erwähnt:

In manchen Arten von Massenunterkünften (z.B. in Krankenhäusern, Alters- und Flüchtlingsheimen, Hotels und Pensionen) war die Befallshäufigkeit recht gross, aber relativ zur Zimmerzahl doch geringer als in den Privatwohnungen. Die Etagenwohnungen waren rd. 8 mal häufiger befallen als die Einfamilienhäuser. Die dichte Belegung der Wohnungen und schlechtere soziale Lage der Inhaber hatten den Befall begünstigt. Dieser war in kleineren Wohnungen häufiger als in grösseren. Die Kellerwohnungen waren nur selten, die Dachwohnungen relativ am häufigsten befallen. Die Befallshäufigkeit nahm innerhalb der Häuser von unten nach oben gleichmässig zu. Eine Ab-

hängigkeit vom baulichen Zustand der Häuser (Beschädigungen durch Bombeneinwirkungen u. dgl.) konnte nicht nachgewiesen werden. Wohl aber zeigte sich, dass alte Gebäude unter sonst gleichen Verhältnissen mehr befallen waren als modernere. In den dicht besiedelten Bezirken der Innenstadt war die Verwanzung viel häufiger als in den Aussenbezirken. Sie betrug im Durchschnitt 14.6% (d.h. jeder 7. Berliner musste in einer verwanzten Wohnung leben) und schwankte zwischen 1.7 und 40% (vgl. Abb.).



Die Verwanzung Berlins im Jahre 1948

Im Herbst 1948 wurden zunächst in ganz Berlin alle befallenen öffentlichen Gebäude und Massenunterkünfte durch besonders dafür ausgebildete städtische Desinfektoren entwest. Sie können – wenigstens so weit sie in den Westsektoren liegen – heute als wanzenfrei gelten, denn jetzt werden sie gut überwacht. Gleichfalls noch im Herbst 1948 wurden – mehr versuchsweise – in dem am stärksten befallenen Bezirk Mitte alle als verwanzt gemeldeten Wohnungen behandelt. Durch eine Anordnung des Magistrats waren die Wohnungsinhaber verpflichtet worden, etwaigen Befall dem zuständigen Gesundheitsamt zu melden. Diese beauftragte dann die Arbeitsgemeinschaft der gewerblichen Schädlingsbekämpfer oder die städtischen Desinfektoren mit der Beseitigung des Befalls. Gegen Ende dieser Aktion erfolgte die endgültige Spaltung der Stadt, und daher mussten – leider – in der Folgezeit die Massnahmen auf die Westberliner Bezirke beschränkt bleiben. Der Ostmagistrat hat sich auch in der Frage der Wanzenbekämpfung nicht bereit gefunden, mit uns zusammen zu gehen.

Im Frühjahr 1949 wurden die beiden in Westberlin am stärksten befallenen Bezirke Wedding und Tiergarten in gleicher Weise wie vorher der Bezirk Mitte

entwanzt. Bei dieser Aktion stellten sich Schwierigkeiten dadurch ein, dass sie in der Zeit der letzten Währungsumstellung („Einführung der Westmark als alleiniges Zahlungsmittel") fiel. Noch im Herbst des gleichen Jahres wurde dann auf Grund einer verbesserten Verordnung eine neue Entwanzungsaktion und zwar dieses Mal gleichzeitig in allen Bezirken Westberlins begonnen. Sie konnte nicht ganz zu Ende geführt werden, hauptsächlich, weil die Jahreszeit schon zu weit fortgeschritten war. Es wurde daher im Jahre 1950 die Bevölkerung erneut zur Meldung noch vorhandenen Befalls aufgefordert und vom 1. Juli bis 30. September nach dem gleichem Modus wieder eine allgemeine Entwanzung vorgenommen.

Als Bekämpfungsmittel waren nur flüssige Kontaktinsektizide zugelassen, die bei der Prüfung durch das Robert-Koch-Institut gezeigt hatten, dass sie gegen Bettwanzen nicht nur eine gute Sofortwirkung sondern auch eine genügend lange anhaltende Dauerwirkung besitzen. In der ersten Zeit wurden nur DDT-Mittel und später – in geringerem Umfange – auch Hexamittel benutzt.

Nach den im Herbst 1949 und im Sommer 1950 durchgeführten Aktionen wurden möglichst genaue Erfolgskontrollen durchgeführt: Die Wohnungsinhaber waren gebeten worden und nach der Verordnung auch verpflichtet, dem Gesundheitsamt zu melden, wenn sich bei ihnen nach erfolgter Entwesung noch lebende Wanzen zeigten. Dieser Meldepflicht ist wohl immer genügt worden, denn es musste in solchen Fällen kostenlos nachgearbeitet werden. Ueberdies waren die beauftragten Desinfektoren und Schädlingsbekämpfer verpflichtet, jede von ihnen ausgeführte Arbeit zu registrieren und dem Gesundheitsamt zu melden. Und schliesslich haben städtische Desinfektoren nach jeder der beiden Aktionen einen grossen Prozentsatz der vorher behandelten Wohnungen, in einigen Bezirken auch alle diese Wohnungen, aufgesucht, die Inhaber oder Hauseigentümer befragt und dort, wo es wünschenswert erschien, auch selbst Untersuchungen auf etwa noch vorhandenes Wanzenvorkommen durchgeführt.

Wie war nun der Erfolg: Unerwartet gering – und zwar, noch nicht einmal 0.2% – war die Zahl der Fälle, in denen die Bekämpfung wegen Ausbleibens des Erfolges wiederholt werden musste. Dies beweist, dass die benutzten Mittel eine gute und dauerhafte Wirkung hatten und dass von den Beauftragten sorgfältig und fachgerecht gearbeitet worden ist. Die als verwanzt gemeldeten und dann entwesten Wohnungen sind also heute zum allergrössten Teil tatsächlich wanzenfrei.

Nachweislich sind rund 50% der 1948 vorhanden gewesenen Verwanzungen heute effektiv beseitigt (und unter diesen 50% befinden sich natürlich alle die Fälle, in denen die Tiere besonders häufig und die deswegen, als Ausgangsherd weiterer Verwanzungen besonders gefährlich waren). Es ist aber anzunehmen, dass der erzielte Erfolg grösser ist als nachzuweisen war. Der Gesundheitssenator hat sich dennoch entschlossen, auch in diesem Jahre noch eine allgemeine Entwanzung durchführen zu lassen. Die Aktion läuft z.Zt. noch und ich kann daher nicht angeben, wieviele Meldungen und Ent-

wanzungen in diesem Sommer erfolgt sind. Es soll wieder eine sorgfältige Erfolgskontrolle durchgeführt werden, und sollte sich dabei herausstellen, dass noch Befall zurückgeblieben ist, so soll auch im nächsten Jahre wieder eine allgemeine Bekämpfung stattfinden. Unsere Gesundheitsverwaltung hat es sich nun einmal zum Ziele gesetzt, zu erreichen,dass man in einigen Jahren sagen wird: Berlin, das früher als besonders stark befallen angesehen wurde, ist unter allen deutschen Grosstädten die am wenigsten verwanzte.

Die grösste Schwierigkeit bei solchen Bekämpfungsaktionen besteht nach unseren Erfahrungen darin, die Bevölkerung zur Meldung möglichst jeden vorhandenen Befalls zu veranlassen. Wir haben uns natürlich nicht damit begnügt, die Meldepflicht anzuordnen – eine solche Anordnung allein ist nur wenig wirksam – sondern wir haben durch immer erneute Presse- und Rundfunkmeldungen, durch Vorträge vor Hausbesitzer- und Mietervereinigungen den Verpflichteten „gut zugeredet" und sie um ein verständnisvolles Mitgehen gebeten.

Steht nun der erreichte Erfolg im rechten Verhältnis zu den aufgewendeten Mühen und Kosten? Wir fanden immer wieder, dass von allen Schädlingsplagen das Wanzenvorkommen im Empfinden der Berliner Bevölkerung – und ähnlich wird es in den meisten anderen Grosstädten sein – ganz eindeutig an erster Stelle stand, dass also hier jeder Erfolg, und wenn er auch nicht 100%ig ist, selbst grossen Aufwand rechtfertigt.

Die Kosten für die Entwesung mussten in den meisten Fällen von dem Hauseigentümer aufgebracht werden. Dieser konnte sie nur dann auf die Mieter abwälzen, wenn diese nach dem Mietsvertrag zur Kostentragung verpflichtet waren. Die Stadt übernahm die Kosten in all den Fällen, in denen es sich um Wohnungen von sozial betreuten Inhabern, oder um stadteigene Objekte handelte. Sie brauchte nur eine verhältnismässig geringe Summe bereitzustellen, weil sie die meisten Arbeiten durch ihre Desinfektoren ausführen lassen konnte. Diese waren, weil die Seuchen im Vergleich zu den ersten Nachkriegsjahren stark zurückgegangen waren, nicht voll ausgelastet, man wollte sie aber noch nicht entlassen, weil die Seuchengefahr immer noch gross war. Der Stadtkämmerer hatte also nur die Kosten für die Bekämpfungsmittel und einige Verwaltungskosten zusätzlich aufzubringen.

Die gewerblichen Schädlingsbekämpfer beteiligten sich gern, denn Sie erhielten viele Arbeitsaufträge, um die sie sich selbst nicht zu bemühen brauchten und die sie zügig hintereinander durchführen konnten. Heute mögen allerdings viele von ihnen das Zustandekommen der Aktionen bedauern, weil sie gemerkt haben, dass in Zukunft nicht mehr wie bisher die Wanzenbekämpfung für sie das tägliche Brot bedeuten wird.

Den wichtigsten Erfolg der durchgeführten Aktionen sehe ich darin, dass der Bevölkerung einer Grosstadt einmal demonstriert wurde, dass Verwanzung nicht ein unvermeidbares und einfach hinzunehmendes Übel ist, sondern dass man sie heute auch unter schwierigen und abnormalen Zeitverhältnissen, wie wir sie in Berlin hatten, durch eine planmässige Gemeinschaftsarbeit tatsächlich beseitigen kann.

DISCUSSION

Mr. **Bishopp**: asks why the use of DDT was discontinued

Mr. **Kemper** replies that it was not discontinued but that BCH (inodorous) was used also after some time.

Mr. **Busvine** recalls a similar campaign in London where bug-infested dwellings were reduced from 98 to 2 per cent. of the total in certain sections.

Mr. **Kemper** adds that in Berlin there were no more than two failures in a thousand treatments.

CONTRIBUTION A L'ETUDE DES VARIETES D'ANOPHELES MACULIPENNIS MEIG. DANS LES ENVIRONS DE BELGRADE: MARECAGE DE PANTCHEVO-PANCEVACKI RIT

par
P. VOUKASSOVITCH, A. MARTINOVITCH et M. POPOVIČ,
Beograd, Yougoslavie

Résumé

Les recherches sur les variétés d'*A. maculipennis* ont été limitées au marécage de Pantchévo et ses environs, dans le voisinage immédiat de Belgrade et ont été poursuivies en 1949 et 1950. Dans 25 endroits déterminés, à intervalles réguliers d'une ou deux semaines, les captures des femelles ont été faites isolément dans des tubes à essais, garnis d'une bande de papier filtre humecté d'eau. Les étables n'arbritant que des vaches ou des vaches et des chevaux ensemble, puis les porcheries, les écuries, les poulaillers et les chèvreries ont servi de lieux de captures.

En tout 19.283 femelles d'*A. maculipennis* et 2 femelles d'*A. hyrcanus* ont été capturées, dont 7262 ont pondu et ont été classées d'après les caractères de leurs oeufs.

Dans tous les lieux et dans toutes les captures trois variétés d'*A. maculipennis* ont été trouvées en tout: *A. m. typicus* Hackett (=*A. m. maculipennis* Meigen); *A. m. messeae* Falleroni et *A. m. atroparvus* van Thiel. La variété *messeae* a été la plus nombreuse, toujours présente et atteint 79.6% du nombre total de pondeuses; en deuxième lieu se place *atroparvus*, également présente dans tous les lieux de captures, avec 15.7% et en troisième lieu *typicus* avec seulement 3.2%. Il y a eu un peu plus de 1% de pontes indéterminées.

Par rapport aux dates des captures, la variété *messeae* a toujours été présente sauf à la fin d'octobre et a été la plus nombreuse en septembre: 90% et en juin: 88.6%. Les variétés: *atroparvus* pendant les deux années, et *typicus*, seulement en 1950, ont surtout été nombreuses à la fin et au début de la période des captures, et seraient jusqu'à un certain point, et surtout la première, le type du moustique d'automne et de printemps.

La variété *messeae* a présenté une très grande variabilité dans les caractères des oeufs servant à la détermination, surtout dans leur coloration et aussi dans l'aspect des flotteurs souvent dans une même ponte. Seulement 45% des pontes de *messeae* répondaient entièrement au type, les autres présentent de plus ou moins grandes déviations; variétés *atroparvus* et *typicus*, plus stables, ont eu 86 et 81% de pontes typiques.

ROGRESS IN MEDICAL ENTOMOLOGY IN THE UNITED STATES

by
E.F.KNIPLING and F.C.BISHOPP
Washington (D.C.), U.S.A.

Intensive research on arthropods affecting the health of man, conducted in he United States during World War II, has continued on many of the more imortant species. These investigations conducted by a number of institutions, ave led to important developments in the medical entomology field.

Many of the recent research programs are planned to obtain information vhich will aid in the control of arthropods throughout the world. The need or a consideration of medical entomological problems on a broad scope was pparent during World War II when military personnel were exposed to attack y arthropods in many parts of the world. Participation of nations in joint ealth programs such as the World Health Organization, Economic Cooperaion Administration and the Pan American Sanitary Bureau has also stimulated esearch on arthropods of world wide importance, particularly the vectors of uman diseases.

Arthropods Affecting Man

Mosquitoes: DDT, first used by military agencies, has been used extenively and with great success by civilians in controlling mosquitoes in the Jnited States. The U.S. Public Health Service and cooperating state agencies ave carried out an intensive house-spraying program with this insecticide vhich has resulted in the virtual elimination of malaria from the United tates. Annoyance due to so-called pest mosquitoes has been greatly reduced n communities in many parts of the nation largely by the application in various orms and by many types of equipment devised for the purpose.

Although DDT and pyrethrum are the most widely used insecticides for osquito control in the United States, research to develop new mosquito nsecticides has continued. This research is for the most part being conduced by the Bureau of Entomology and Plant Quarantine with funds provided y and with the cooperation of the Department of Defense, the U.S. Public Iealth Service, the Tennessee Valley Authority, and by various state health epartments and experiment stations. Benzene hexachloride is used in certain reas in Florida where strains of salt marsh mosquitoes (*Aëdes taeniorhynhus* Wiedemann and *A. sollicitans* Walk.) resistant to DDT have appeared. : is particularly effective against adults. Dosages ranging from 0.05 to 0.1 ound per acre of the gamma isomer of benzene hexachloride have proved qually as effective as 0.2 to 0.3 pound of DDT. Toxaphene has also shown onsiderable promise as a larvicide, although generally less effective than DT. TDE and methoxychlor, two analogs of DDT have proved almost equal DDT as larvicides, although they compare less favorably with the latter,

against adults, either as residue treatments or as a space spray. Chlordane is highly effective against larvae and adults and possesses considerable residual action but not equal to that of DDT. Dieldrin, which is still under experimentation, is among the most effective of the available insecticides against larvae and adults.

In view of the appearance of strains of mosquitoes resistant to DDT, special research is now under way chiefly by the Bureau of Entomology and Plant Quarantine, and the Department of Health in California to develop materials or combinations of materials which will be effective against such strains.

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PROGRESS IN MEDICAL ENTOMOLOGY IN THE UNITED STATES

by
E.F.KNIPLING and F.C.BISHOPP
Washington (D.C.), U.S.A.

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Many of the recent research programs are planned to obtain information which will aid in the control of arthropods throughout the world. The need for a consideration of medical entomological problems on a broad scope was apparent during World War II when military personnel were exposed to attack by arthropods in many parts of the world. Participation of nations in joint health programs such as the World Health Organization, Economic Cooperation Administration and the Pan American Sanitary Bureau has also stimulated research on arthropods of world wide importance, particularly the vectors of human diseases.

Arthropods Affecting Man

Mosquitoes: DDT, first used by military agencies, has been used extensively and with great success by civilians in controlling mosquitoes in the United States. The U.S. Public Health Service and cooperating state agencies have carried out an intensive house-spraying program with this insecticide which has resulted in the virtual elimination of malaria from the United States. Annoyance due to so-called pest mosquitoes has been greatly reduced in communities in many parts of the nation largely by the application in various forms and by many types of equipment devised for the purpose.

Although DDT and pyrethrum are the most widely used insecticides for mosquito control in the United States, research to develop new mosquito insecticides has continued. This research is for the most part being conducted by the Bureau of Entomology and Plant Quarantine with funds provided by and with the cooperation of the Department of Defense, the U.S. Public Health Service, the Tennessee Valley Authority, and by various state health departments and experiment stations. Benzene hexachloride is used in certain areas in Florida where strains of salt marsh mosquitoes (*Aëdes taeniorhynchus* Wiedemann and *A. sollicitans* Walk.) resistant to DDT have appeared. It is particularly effective against adults. Dosages ranging from 0.05 to 0.1 pound per acre of the gamma isomer of benzene hexachloride have proved equally as effective as 0.2 to 0.3 pound of DDT. Toxaphene has also shown considerable promise as a larvicide, although generally less effective than DDT. TDE and methoxychlor, two analogs of DDT have proved almost equal to DDT as larvicides, although they compare less favorably with the latter,

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methyl carbinol) a material in itself non-toxic to flies will increase the efficacy of DDT against resistant forms. Other materials even more promising are now under investigation as well as compounds designed to increase the efficacy of lindane against lindane-resistant flies.

The failure of residual treatments to maintain fly control and safety considerations have resulted in a renewed interest in the use of pyrethrum space sprays and aerosols. Extensive research has been conducted for over ten years to develop more effective synergists for pyrethrum for fly control. A number of compounds including piperonyl butoxide, Sulfoxcide, sesame oil, and N-propyl isome are now in wide use for this purpose.

The insecticide resistance problem has emphasized the need for supplemental fly control measures, especially sanitation. The U.S. Public Health Service is conducting studies to determine where various species of flies are breeding and the relative value of sanitation in reducing the fly population in urban communities.

The Public Health Service is also conducting community-wide control programs, and their affect on disease incidences in several experimental areas, utilizing various insecticides and methods of application.

The Bureau of Entomology and Plant Quarantine has demonstrated the value of radioactive isotopes as markers for house flies and blow flies in population density and migration studies. Radioactive phosphoric acid (P-32) added to water and fed to flies provides a simple and satisfactory method of making flies radioactive and they can be readily detected with conventional equipment.

Research on the mode of action of insecticides against normal and insecticide-resistant strains is under way at the University of Illinois, University of California, and in the Bureau of Entomology and Plant Quarantine. Particular efforts are being made to identify the degradation products of insecticides.

Mites: The development of highly effective toxicants for treatment of clothing to protect individuals from attack by chigger mites (*Eutrombicula* and related genera) which cause severe irritation and in some areas transmit mite typhus, represents an outstanding development. Dimethyl phthalate was developed and used successfully for this purpose during the last war. Other effective and persistant acaricides have been developed for treatment of clothing, including benzyl benzoate, diphenyl carbonate, benzil, and p-cresyl benzoate. Clothing treated with these will prevent chigger attack after 2 to 5 or more launderings. However, with the exception of benzyl benzoate there is still some question of safety of these materials from the standpoint of skin irritation and sensitization. Combination M–1960, already mentioned, is less persistent than benzyl benzoate alone, but is an excellent treatment to prevent chigger attack.

Several of the newer insecticides applied as sprays or dusts will effectively destroy the mites in their natural habitat. Chlordane or toxaphene, applied at the rate of about two pounds per acre, and gamma benzene hexachloride at about 0.5 pound per acre are among the most effective materials.

Research on control of the itch mite, *Sarcoptes scabiei*, has been limited, although significant progress has been made. Several compounds including benzyl salicylate; methyl ester of 4 tertiary butyl phenoxy acetic acid; methyl ester of (3, 4, methyl–iso–propyl) phenoxy acetic acid; and 1, 2, 3, 4, tetrahydro–2–naphthol–N–butyrate are among the materials that appear equal to or superior to benzyl benzoate. The safety of these materials has not been proved although there was no evidence of toxic reaction in cases treated. Gamma benzene hexachloride at a concentration of one percent in a vanishing cream base has come into rather extensive use for scabies control in the United States.

Ticks: Various investigators with the state institutions in New York and Massachutsetts and with the Bureau of Entomology and Plant Quarantine have shown that DDT, toxaphene, or chlordane, applied as dusts or sprays to vegetation and ground litter at the rate of 1 to 2 pounds per acre where ticks occur, have given good control of the American dog tick (*Dermacentor variabilis* Say), one of the principal vectors of Rocky Mountain spotted fever.

During World War II, it was found that Indalone, benzyl benzoate, and other insect repellents give some measure of protection against ticks when applied to clothing. Since the war the U.S. Public Health Service found N-butyl acetanilide to be a superior tick repellent. Further work by the Orlando laboratory with this and other materials has led to the development of the combination treatment, M–1960, against ticks, mites, mosquitoes, and fleas. In addition, several materials used alone have shown promise, including hexyl mandelate, and undecylenic acid. The Carbide and Carbon Chemical Corporation is also experimenting with dibutyl adipate, which has shown promise as a repellent for the American dog tick.

Fleas. The value of DDT for controlling fleas in buildings and on grounds was established during the last war. Since the war, the U.S. Public Health Service, cooperating with State Health Departments, has carried out an extensive and successful murine typhus control program in the southern part of the United States.

The Orlando laboratory of the Bureau of Entomology and Plant Quarantine has found several materials equal to or more toxic than DDT against the oriental rat flea and the common cat flea. These include chlordane, lindane, toxaphene, heptachlor, dieldrin, and aldrin. The value of these insecticides in practical control has not been fully investigated.

Undecylenic acid, N-butyl acetanilide, hexyl mandelate, and benzyl benzoate are among the most promising flea repellents found for treatment of clothing. In addition mixture M-1960 has given good protection against the cat flea and the oriental rat flea.

Lice. The development of DDT by workers in various countries to control human lice represents one of the outstanding advances in medical entomology. The addition of 0.2 percent of pyrethrins and one percent of a synergist to a 10 percent DDT powder greatly increases the rapidity of paralytic action on the lice as well as against fleas. The possibility of employing pyrethrum

or allethrin in combination with certain synergists or other chlorinated hydrocarbon insecticides, particularly lindane, for louse control is being investigated.

Black Flies (Simuliidae). Several agencies in the United States have demonstrated that DDT and other chlorinated hydrocarbon insecticides, particularly TDE, possess exceptional toxicity to larvae of black flies breeding in streams. Tests in New England and Alaska have shown that minute amounts of these insecticides applied to portions of infested streams, as oil solutions or emulsions, will eliminate larvae of certain species. Sprays against adults have given erratic results.

Bedbugs. The value of DDT for the control of the bedbug has been demonstrated in many parts of the world. Due to the exceptional control obtained with this insecticide, very little research has been carried out with other materials.

Livestock Pests. Excellent progress has been made in research on various arthropods affecting livestock in the United States.

Toxaphene, TDE, and methoxychlor have been found to be comparable with DDT for controlling the horn fly *(Siphona irritans* L.). Animals treated with sprays containing 0.5 percent concentration of these insecticides will be protected for 3 to 4 weeks. Because of the fear of possibly contaminating milk with harmful residues, only methoxychlor is recommended for controlling horn flies on dairy cattle. None of the chlorinated insecticides are considered highly effective in protecting cattle from stable flies *(Stomoxys calcitrans* L.) or the horse and deer flies *(Tabanidae)*. Pyrethrum used in combination with one of the synergists such as piperonyl butoxide, n-propyl isome, sulfox-cide or sesame oil concentrate will control horn flies for about one week and will also protect animals from attack by stable flies, horse flies, and deer flies for 2 to 4 days.

All of the chlorinated hydrocarbon insecticides, including DDT, gamma benzene hexachloride, toxaphene, chlordane, methoxychlor, and TDE have been shown to be excellent control agents for lice attacking cattle, swine, sheep and goats. Sprays containing a 0.5–percent concentration of any of the insecticides named, except lindane or benzene hexachloride, are generally recommended for use on beef cattle and swine. Gamma benzene hexachloride at concentrations ranging from 0.03 to 0.05 percent provides excellent control of cattle lice. Lice on sheep and goats and also the sheep tick *(Melophagus ovinus* Latr.) are controlled with one dipping in concentrations of 0.025-percent of lindane or 0.25–percent of the other chlorinated hydrocarbon insecticides. Thorough spraying of sheep and angora goats, with twice the above concentration, following shearing or before the wool reaches a length of more than a few inches gives excellent control of lice and the sheep tick.

Toxaphene is considered at present the most satisfactory insecticide for the control of ticks on livestock. Sprays or dips containing 0.5-percent of toxaphene will kill all engorged forms of the lone star *(Amblyomma americanum* L.), Gulf Coast *(A. maculatum* C.L.Koch), and winter tick *(Dermacentor*

albipictus). Treated animals are protected from reinfestation by the lone star and Gulf Coast ticks for 2 to 3 weeks and for about 6 weeks against the winter tick. Toxaphene is also highly effective against the cattle tick *(Boophilus annulatus* Say). DDT does not kill all engorged ticks but provides protection against reinfestation comparable with that obtained from toxaphene. Lindane on the other hand, is highly effective in killing all stages of the tick but the residual protective action on animals is of short duration. Sprays or dips containing 0.025-percent gamma benzene hexachloride plus 0.5-percent DDT provide control comparable with toxaphene.

DISCUSSION

Mr. **Swellengrebel**: asks if he has heard right that *Aëdes taenirohynchus* and *A. sollicitans* have been found to become DDT-resistant.

Mr. **Bishopp** adds that there are a few more instances of mosquitoes resistant to DDT.

Mr. **Buxton** asks if there are conclusive laboratory tests to substantiate this.

Mr. **Bishopp** says there are.

Mr. **Jayewickreme** asks if BHC is effective against the DDT resistant mosquitoes.

Mr. **Bishopp** replies that it is.

Mr. **Theodor** found DDT almost wholly ineffective against *Argasidae.*

Mr. **Bishopp** says he is surprised to hear this. It certainly is not the experience in the U.S.A.

Mr. **Bergman** asks if resistance to DDT of human lice has been observed.

Mr. **Bishopp** answers in the affirmative.

Mr. **Busvine** enquires about the use of DDT powder against lice.

Mr. **Bishopp** replies that powders are in use matching the colour of the hair; emulsions are also used.

Mr. **Leclercq** asks for an explanation of DDT resistance.

Mr. **Buxton** answers that, whatever the explanation may be, it certainly is not thickening of the cuticle.

Mr. **Goodwin-Bailey** asks about synergists in use with pyrethrum.

Mr. **Bishopp** gives the information required.

Mr. **Bertram** says that some years ago he carried out work on the use of DDT and BHC against the biting and the sucking lice of cattle. About that time American workers reported an ovicidal effect by BHC; but not by DDT. His own observations confirmed this. Do any of the newer insecticides exhibit an ovicidal action?

Mr. **Bishopp** replies that none of the newer insecticides have yet been shown to have an ovicidal action; nor has the ovicidal effect of BHC been more fully studied so far as known.

Mr. **Pal** mentions cashew nutshell oil as a synergist to DDT in relation to *Anopheles darlingi* resistant to DDT.

Mr. **Bishopp** gives the necessary information on this subject.

MIDGE (CULICOIDES) CONTROL IN SCOTLAND

by

D.S. KETTLE

Glasgow, Scotland

In the space available it will only be possible to review briefly the progress made towards a solution of the Scottish Midge problem and to indicate the lines of future work.

In 1945 a Sub-Committee, set up under the Department of Health for Scotland, began investigations into the nature of the midge problem. They found that as regards nuisance value the most important insect was *Culicoides impunctatus* Goetghebuer, which was not only extremely abundant and widespread but also showed a marked preference for man (CAMERON et al. 1946 and Anon. 1948). Thus whilst it might form only 60% of the *Culicoides* population on the wing it was often the only species attacking man. Of the other 26 Scottish species five or six may be of local importance, whilst the other twenty can be ignored. It was concluded from this preliminary survey that for practical purposes the control of midges can be regarded as the control of *C. impunctatus.*

Concurrent with this investigation field experiments had shown that DMP effectively repelled midges (CAMERON, 1946) and with this means of individual protection available, attention could now be concentrated on the development of a suitable method of eradicating *C. impunctatus.*

From the data then available there seemed reasonable grounds for believing that protection could be given by the application of barrier sprays. To test this two field trials were conducted in which DDT, either as an emulsion or suspension, was applied at the rate of 2½ lbs per acre under both woodland and moorland conditions. The effect of the treatment was measured by exposing "sticky" traps at 44 catching stations of which there were 22 in each area. A station consisted of three traps placed vertically above each other with their centres 2ft., 6ft. and 10ft. above the ground. The unexpected result was that the treatment produced no effect at all on the *C. impunctatus* population. This was not due to their possessing any particular resistance to DDT since laboratory experiments showed that they were as sensitive as *Musca domestica* L. to DDT deposits. For some reason, which is not understood, the insects in the field failed to acquire a lethal dose (KETTLE 1949).

However so completely did the experiments fail that it was possible to regard all the observations as having been made on an untreated population and their analysis produced much valuable information. Thus the seasonal distribution was found to be bimodal and not unimodal as expected. After due consideration of all the possibilities it was suggested that *C. impunctatus* in Scotland is composed of two races which are morphologically inseparable but biologically distinct (KETTLE 1950).

Secondly it was shown that the distribution of *C. impunctatus* in both areas remained constant not only from week to week but also from year to year. Moreover, when the total catches were plotted on plans of the areas it was revealed that there were a few centres of high midge density away from which there was a regular decrease in density with increasing distance. In one area there were two high centres one on the moorland and the other in the woodland whilst in the other area there were two woodland centres of high density and a rather larger diffuse moorland centre (KETTLE 1951a). The obvious interpretation of this distribution was that the midges were emerging from a few concentrated breeding sites from which they dispersed outwards in all directions. An important practical conclusion can be drawn from this result because it follows that if these small breeding places could be located and the contained larvae destroyed than relatively large areas would be rendered free from midges. The accuracy of this interpretation was confirmed by the discovery of one of the postulated breeding places.

Knowing the exact position of a breeding place and the surrounding population densities, it was possible to calculate the regression of midge density on distance. This is of considerable value since the nuisance caused to man by *C. impunctatus* is directly proportional to its density. It was found that 65 yards away from the breeding site the midge density was 1/10th of its value at the centre of breeding; 130 yards away it was 1/100th and 195 yards away it was 1/1.000th. Although this regression has been based on data from a single isolated breeding site it has been calculated that even if the breeding sites were continuous the density would not be more than doubled at the largest distance. That is 195 yards away the population density will not be more than 1/500th of its value at the centre of breeding (KETTLE 1951b). Therefore for practical purposes any location can be adequately protected if all the breeding sites within 200 yards are destroyed.

To achieve this it is necessary to know two things. Firstly, how to recognise a *C. impunctatus* breeding site and then having found it how to treat it. The actual treatment should not prove too difficult because it is known from the work of HILL & ROBERTS (1947) at Liverpool and CAMERON (1948) in Scotland that *Culicoides* larvae can be destroyed by the surface application of either DDT or BHC. However, there still remains the problem as to where the insecticide should be applied. Before any progress could be made towards determining the breeding site of *C. impunctatus* it was necessary to be able to identify with certainty their larvae from those of other *Culicoides*.

Unfortunately there were no larval keys available and the few published descriptions proved inadequate and therefore an attempt was made to supply the necessary information. As a result of this work adequate descriptions and keys have been prepared for the early stages of 28 of the 32 *Culicoides* species found in Great Britain (KETTLE & LAWSON in the press).

In the course of this taxonomic investigation many different larval habitats were sampled and when the results were analysed it was found that

each species showed marked breeding preferences. Thus two species were only found in cow dung lying naturally in the field; another four were confined to coastal saline marshes; some bred in muddy fresh water swamps whilst others chose fresh water marshes. *C. impunctatus* however was found in none of these but was restricted to the wetter areas of the moorland, especially to the association of Juncus articulatus 'sensu lato' and Sphagnum spp.

This correlation opens up interesting possibilities because if midge control in Scotland is to be carried out on a nation wide scale it is essential that a method should be developed which can be understood by the layman. The locating of a breeding place by soil sampling is too specialised and tedious to be of use other than as a research tool. What is needed is a simple, readily understood description of a *C. impunctatus* breeding site. Perhaps the jointed rush – bogmoss (J. articulatus - Sphagnum) definition will serve this purpose, but its usefulness will be directly proportional to its universal applicability. Therefore it has been decided to spend the next two years checking the validity of this hypothesis in representative areas of Scotland. Once the breeding places of *C. impunctatus* can be identified on sight it should be a relatively simple matter to find a suitable larvicide especially as *C. impunctatus* larvae are quite accessible with at least 75% of them occurring in the top inch of the soil.

There seems, therefore, to be reasonable grounds for hoping that in a few years time there will be available a simple method for controlling *C. impunctatus* in Scotland. One which can be used by the layman to protect the environs of his dwelling whether it be a croft, farm or hotel.

Summary

This paper reviews recent advances towards a solution of the Scottish midge problem. It deals mainly with the value of ecological findings in the development of a rational control scheme.

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DISCUSSION

Mr. **Gordon** reminds the audience that the work in Scotland began on account of the nuisance value of midges, but that they are vectors of Filarias in the tropics.

Mr. **Galliard** asks if the midges bite also in the open or only in the woodland.

Mr. **Kettle** answers that they bite likewise in the open in the vicinity of small collections of water.

Mr. **Galliard** remarks that they never bite in the open in Africa.

Mr. **Kettle** thinks it is a matter of humidity.

Mr. **Galliard** enquires how many species of the genus *Culicoides* are known.

Mr. **Kettle** answers: 32.

Mr. **Bertram** suggests that the absence of imagocidal effect of DDT was due to the midges being irritated and repelled by that chemical.

Mr. **Kettle**, on the contrary, believes that his curves cannot be explained that way. *Culicoides* show a bimodal curve of distribution. The species *C. impunctatus* comprises a spring-form and a separate summer-form.

Mr. **Gordon** notes there were traps at three different heights. He asks if there was any difference in the numbers trapped at these heights.

Mr. **Kettle** replies that in woodlands more were trapped at 10 ft. than at 2 ft. In open moorlands there was no difference unless bracken were plentyful. In that case the 6 ft. trap showed larger numbers. Among rushes (genus Juncus) the 2 ft. trap caught more.

Mr. **Busvine** asks if *Culicoides* can be controlled in extensive areas.

Mr. **Kettle** believes that general control will be hardly economically possible, except in tourist centres. Individual protection may be practicable.

Mr. **Gordon** asks what *Culicoides* do feed on, besides man.

Mr. **Kettle** is unable to say; birds and deer were very rare in the area examined.

Mr. **Reid** asks what kind of blood is found in *Culicoides*.

Mr. **Kettle** cannot answer the question, because it is rare to find an engorged midge.

PROBLEMS IN THE TRANSMISSION OF FILARIASIS

by
R.M.GORDON
Liverpool, Great Britain

For the propagation of any species of filaria parasitising man three factors are essential; firstly an infected vertebrate host, secondly a susceptible arthropod vector and thirdly a susceptible vertebrate host. In the past it was believed that the part of the vertebrate host was always played by man, and that of the arthropod by some insect which conveyed the infection from man to man. More recent investigations, however, suggest that man may not be the only host of some, at any rate, of the filarial infections he is prey to. This wider view, if accepted, at once alters our concept of the part played by the arthropod vector. So long as we believed man to be the only host of the filarial worms known to parasitise him it followed that the helminths taken up from his blood or tissues by a susceptible arthropod vector would perish unless the vector was given an opportunity, after a suitable incubation period, of again biting man. If, however, man is not the only mammalian reservoir then it follows that the infection taken up from the human host by a vector destined not again to attack man may, from Nature's point of view, not be wasted but given an opportunity to develop in some mammalian host other than man. The presence of such an animal reservoir has not, so far, been established on a firm scientific basis, and in a short paper such as this it is not possible to discuss the evidence for and against such a view. It is sufficient to state that in the case of Acanthocheilonema perstans (Manson) infections there is evidence to support the view that chimpanzees may act as a reservoir (PEEL & CHARDOME, 1946) and that Loa loa (Guyot) infections may occur in monkeys inhabitating the forest canopy in the Cameroons (GORDON *et al.*, 1948). In our present state of ignorance it would be unwise to extend our speculations too far but, granted the presence of an animal reservoir, it seems reasonable to suppose that it may be partially maintained by arthropods which rarely, or never, bite man; in short that the transmission of certain forms of filariasis is comparable to that known to occur in such insect-borne diseases as yellow fever and certain rickettsial and spirochaetal diseases common to both man and animals. If, for the moment, we accept these tentative suggestions and apply them to the three factors originally regarded as essential to the propagation of filarial infections, we can express the result as follows : -

1. Infected vertebrate host. Man or lower animals.
2. Susceptible arthropod vector. Biting only man, or biting man and lower animals, or biting only lower animals.
3. Susceptible vertebrate host. Man or lower animals.

The necessity for the presence of these three factors is obvious, but it is not so obvious why when they are present the propagation of filariasis should vary greatly, not only in different species of filariasis but in the same species under different conditions and, not uncommonly, in the same species under apparently identical conditions. Unquestionably, many of the influencing factors are inherent in the vertebrate host; thus, it has been suggested (BERTRAM, 1949) that the microfilariae circulating in the blood of the vertebrate host, although viable, may be aged and incapable of development in the otherwise susceptible arthropod, or the recipient host, although susceptible to infection – in the sense of allowing the transmitted filariae to develop to adults – may not subsequently harbour microfilariae in the peripheral blood in sufficient numbers to infect the vector, a not uncommon finding in A. perstans infections and also, although not so commonly, in loiasis (KERSHAW, 1950).

These problems, however, are not the direct concern of the entomologist, and it is with certain factors influencing the taking up of the parasite by the arthropod and its subsequent development in, and deposition by, the vector that I propose to deal. For this purpose I shall confine my remarks to observations made by my colleagues and myself on the part played by flies of the genus *Chrysops* in the transmission of L. loa. It will be necessary, however, to compare these findings with those of other observers of various forms of filariasis. In this connection reference will be made to the transmission of A. perstans by *Culicoides*; I am well aware of the interesting and important observations of Dr. HENRARD and his colleagues (HENRARD & PEEL, 1946) which have convinced these distinguished workers that *C. grahami* Austen is not the vector of A. perstans, but for the moment I propose to regard their opinion as *sub judice*.

I. The taking up of the parasite by the vector

A. The finding of the vertebrate host.

Chrysops, like other species of *Diptera* concerned in the transmission of filariasis, requires a blood-meal as well as fertilisation before the ovaries ripen and fertile eggs are laid. In the case of vectors such as *Simulium*, *Culicoides* and various species' of mosquitoes, males as well as females are readily captured in the field and the available evidence suggests that the females are usually fertilised near the breeding places and from there proceed, more or less directly, in search of a blood-meal. In the case of *C. silacea* (Austen) and *C. dimidiata* (v.d. Wulp), the West African vectors of loiasis, the situation is very different. Whereas flies bred from larvae collected in the streams exhibit the usual proportion of males and females, it has so far proved impossible to find a single male of either of these species amongst the many thousands of flies which have been captured in the field. Similarly, we are ignorant of the movements of *Chrysops* after it has partaken of its blood-meal. In the case of the other vectors already referred to it is usually possible to capture females with the blood-meal at vari-

ous stages of digestion and the ovaries at various stages of development, but in the case of *C. silacea* and *C. dimidiata* this is not the case. These species of *Chrysops* are almost invariably captured when attacking man or, less commonly, cattle, and under these circumstances the ovaries are almost invariably in a state of very early development, although there may be evidence, in the form of one or more retained eggs, of a previous oviposition. It follows therefore that before planning widespread methods of control of these species, it will be necessary to gain further information regarding the movement of the flies both before and after they have obtained their blood-meal. At present we lack such knowledge, but we have collected a limited amount of information which suggests that at Kumba in the Cameroons, where loiasis is particularly common, male and female flies emerging from the pupae occurring on the banks of low-lying streams make their way to the surrounding forest. The now fertilised females live in the high forest canopy and obtain their blood-meals either from monkeys in the canopy, or else, when attracted by movements on the ground below, they descend to feed on men. Having obtained their blood-meal they return to the forest canopy where they remain until the ovaries are ripe, at which time they descend to oviposit near the streams.

B. The time of feeding in the vertebrate host.

In the case of vectors of those filarial infections in which the microfilariae exhibit no periodicity, the time of feeding selected by the vector would appear to be unimportant. Whereas in Wuchereria bancrofti and L. loa infections, where the microfilariae exhibit periodicity, the time of feeding will influence the number of larvae available for ingestion. It has been shown (CREWE & O'ROURKE, 1951) that *Chrysops* in the Cameroons seeks its human blood-meals between 8 a.m. and 6 p.m. and that the largest number of bites are liable to be contracted between 10-11 a.m. and 2-4 p.m., periods which are included in the maximum density level of the microfilariae of L. loa in the blood (KERSHAW, 1950).

C. The site selected for feeding on the vertebrate host.

In O. volvulus infections the concentration of the microfilariae in the neighbourhood of the nodules plays a part in determining the number of larvae taken up by the feeding *Simulium*, but in other filarial infections we have no evidence of microfilariae concentrating at a particular body site.

D. The method of feeding adopted by the vector.

So far as we are aware, all the blood-sucking Diptera so far investigated obtain their blood-meal by "pool-feeding", that is to say by lacerating with the mouthparts the vessels of the peripheral circulation and sucking up the blood from the pool thus formed; although certain insects, notably mosquitoes, obtain some of their meals by "intra capillary feeding", in which case the fascicle is inserted within the lumen of the capillary. It is obvious that when the latter method of feeding is adopted the chances are greatly reduced of the fly taking up those species of microfilariae, such as Onchocerca volvulus (LEUCKART) and Streptocerca, which inhabit the cutic-

ular lymph spaces. In the case of pool feeding it has been shown that the number of microfilariae of the blood-inhabiting type taken up will depend on various factors concerned with the nature of the vector's mouthparts. *Simulium*, with its mouthparts adapted to scarifying and tearing the skin, is particularly well-suited to take up skin-inhabiting microfilariae during the period prior to reaching a blood vessel, but having tapped the blood supply it unquestionably takes up any species of blood-inhabiting microfilariae – although these, unlike O. volvulus larvae, undergo no further development. We have recently devoted considerable attention to studying the feeding habits of *Culicoides* sp. and believe that it is essentially a pool feeder and capable of taking up blood-inhabiting microfilariae, and that contrary to the observations of HENRARD and his colleagues, whose work has already been referred to, *C. grahami* is capable of sucking up the microfilariae of A. perstans is considerable numbers, although we are not able to state whether the ingested microfilariae undergo further development. As regards *Chrysops*, our observations show that flies belonging to this genus are essentially pool feeders and readily take up the larvae of L. loa which escape from the extensively lacerated skin capillaries.

E. The size of the blood-meal.

It has been shown by various workers that the number of microfilariae taken up by flies of the same species, feeding to repletion on the same host at the same time, varies considerably and we have previously shown (GORDON & LUMSDEN, 1939) that these variations are explainable not only by the method of feeding adopted by the vector, but also by variations in the concentration of the microfilariae in different capillaries and, possibly, on their ability to escape from lacerated vessels. When, however, it is desired to estimate the numbers of microfilariae likely to be taken up by different species of flies feeding on the same infected host, then, unquestionably, the most important influencing factor will be the amount of blood normally taken up by a particular species. Thus we have calculated that *Culicoides grahami* feeding to repletion takes up approximately 0.04 c.mm. of blood, and feeding on a patient with five blood-inhabiting microfilariae per c.mm. of blood it will take up, on the average, only one microfilaria at every fifth meal. *C. silacea,* on the other hand, takes up approximately 20 c.mm. of blood when fully gorged and will, therefore, on an average, take up some 100 microfilariae at a single meal from the same patient. It must not be thought, however, that the number of microfilariae taken up at any one meal is all important, for a vector such as *Culicoides* may compensate for the small size of its blood-meal not only by the number of meals it partakes of during its lifetime but also by its density.

F. The number of meals partaken of during the vector's lifetime.

Other things being equal the greater the number of blood-meals partaken of by the vector during its lifetime, the greater the chances of its acquiring infection. Considerable information is available regarding the number of blood-meals required by certain mosquito vectors of Wuchereria bancrofti

and W. malayi, but we lack similar knowledge concerning the requirements of the different vectors of other species' of filaria. The life-cycle of *C. grahami* is not known, but if it resembles that of other species in the same genus it is probable that the adults feed every three or four days and live for about three weeks; whereas our limited observations suggest that the African species' of *Chrysops*, responsible for the transmission of loiasis, although enjoying a longer adult existence, are unlikely to take more than two full blood-meals during this part of their life-cycle. It follows that the small size of the blood-meal partaken of by *Culicoides* and, therefore, its diminished chances, as compared with *Chrysops*, of taking up microfilariae, may be partially compensated for by the larger number of blood-meals required by *Culicoides*.

G. The infective density of the vector.

It is generally recognised, although sometimes forgotten, that neither the proportion of potential vectors of a particular species found infective, nor the density of the vector is necessarily indicative of the importance of that species as a transmitter; and that reliance must be placed on knowledge of both factors, i.e. the density and the infection rate combined – generally referred to as the infective density – meaning the number of infective bites awaiting distribution in a given area at a given time. In this connection it is of some interest to compare the results of dissecting adult *C. silacea* and *C. grahami*, captured when attacking the human host at Kumba in the Cameroons, Of some 2,000 *Chrysops* dissected about four per cent were found to be infective, whereas of 400 *C. grahami* only 0,2 per cent showed the presence of filaria in the head and proboscis. As judged by the infection rates just quoted, it would appear, therefore, that *Chrysops* is some twenty times more efficient as a vector of L. loa than is *Culicoides* of A. perstans. When, however, we come to consider the respective densities of these two vectors, this marked difference becomes reduced or even eliminated, for our observations suggest that at Kumba each individual during the course of 24 hours receives ten or even 20 bites from *Culicoides* for every one bite received from *Chrysops*.

II. The development of the parasite in the vector and the chances of its transfer to the vertebrate host

In order that the parasite may complete its life-cycle in the vector and establish itself in a fresh vertebrate host, not only must the vector be susceptible to infection (in the sense of allowing development of the parasite to the infective stage), but it must live longer than the period required by the parasite to become infective and, subsequently, partake of one or more blood-meals. As regards susceptibility to infection the most intensely studied of the human filarial infections – W. bancrofti – is known to be transmitted by more than 20 different species of mosquitoes, whereas much fewer species of Diptera have been incriminated in the transmission of the remaining forms of filariasis, possibly because most of the latter have been much less fully

investigated. Up to the present day three species of *Chrysops* (*C. silacea*, *C. dimidiata* and *C. distinctipennis* Austen) have been shown to be vectors of L. loa. On the other hand, comparatively few species of biting flies have been the subject of experiments and it is quite possible that some other blood-sucking insect is capable of transmitting the disease. The three vector species of *Chrysops*, already referred to, appear to be highly susceptible to infection with L. loa, as judged by the proportion of ingested microfilariae reaching the infective stage. These larvae produce a massive invasion of the fly's labium, head and body, yet they appear to produce little effect on the insect's life span, although they may reduce its range of flight, and it appears probable that a high proportion of the infected flies survive the 10-14 days necessary for the full development of the ingested microfilariae and that the majority of these now infective flies partake of one or more blood-meals.

III. The deposition of the parasite by the vector

Until very recently the breeding places and larval stages of the African species of *Chrysops* which act as vectors of loiasis were unknown and, surprising as it may seem, we are still ignorant of their oviposition sites in nature. As a result we cannot state from which site the fly harbouring the infective form approaches man, although as already stated there is some evidence that it does so from the forest canopy to which it has returned after oviposition. Once alighted on the human host the movements of the fly and the escape of the larvae from the labium have been vividly described by CONNAL & CONNAL (1922) and, with one exception, we can confirm the classical account of these early workers. The exception referred to is their statement that many of the larvae fall or are shaken on to the skin some little distance from the puncture made by the mouthparts of the feeding fly and that these larvae rapidly penetrate into the skin, a statement which is repeated by many later workers. We also have observed the rapid disappearance of actively-writhing infective larvae when applied to the skin surface, but we have failed completely to demonstrate their ability to penetrate the intact *stratum corneum*. On the contrary, washings of the skin surface after the disappearance of the larvae have always led to the recovery of some of the worms, and numerous serial sections cut through the area of exposure have failed to demonstrate the presence of larvae in the tissues. This does not mean that we regard it as proven that the infective larvae of L. loa are incapable of penetrating the intact skin – merely that we consider evidence of such an ability is lacking. This is a point of some importance, since the infective fly during the act of feeding usually deposits large numbers – anything up to 100 – of larvae on the skin and if these, as well as those escaping from the labium directly into the feeding puncture, can undergo further development, one would expect much more massive infection of the human host than occurs in the case of other fly-borne filarial infections, in which only a few infective larvae escape from the feeding fly.

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DISCUSSION

Mr. **Webb** asks whether *Chrysops* bites mammals other than man.

Mr. **Gordon** replies that it does so freely in the laboratory; but that is no proof that it does in nature.

Mr. **Buxton** asks (1) whether *Chrysops* can be trapped, marked, and retrapped; (2) whether the members of the speaker's staff were infected.

Mr. **Gordon** replies (1) that he has no personal experience regarding that point; (2) that all members of the staff, except himself, developed Calabar Swellings. As a protection they used screening, clothes covering large parts of the body. Dimethyl phthalate protected for 2 hours.

Mr. **Bertram** asks if there was any difference between flies caught in nature and bred in the laboratory.

Mr. **Gordon** cannot answer that question because he infected wild flies only.

Mr. **Galliard** says that in Indo China aboriginal tribes (Mois) constituted the virus reservoir for W.bancrofti. They were heavily infected (50%) but showed no apparent symptoms, as against the Indochinese with 7% infection and numerous clinical cases. He asks whether similar conditions prevail in Onchocerciasis.

Mr. **Gordon** replies that he did not come accross conditions quite comparable with the ones GALLIARD described.

THE GLOSSINAE OF PORTUGUESE AFRICA

by

J. FRAGA DE AZEVEDO and A. TEIXEIRA FEIJÓ COLAÇO

Lissabon, Portugal

Summary

The importance of the Tsetse fly in the Portuguese African territories is still, at the present date, considerable, in view of its wide diffusion in those territories and the important rôle it plays as a transmitter of pathogenic trypanosomas to man and animal.

The distribution of the various species in Portuguese Africa is reported and rightly so as its percentage of infection by trypanosomas.

Parallel reference is made to the distribution of human trypanosomas and those of animals and to its medical, social and economic importance.

The ecology of the Glossinae in relation to the part they play in the transmission of the trypanosomas is considered and is summed up in a resumé of the organisation of the fight against trypanosomiasis in Portuguese African territories.

SOME NEW TAXONOMIC CHARACTERS FOR SPECIFIC DIAGNOSIS OF IXODIDAE

by

B. FELDMAN-MUHSAM

Jerusalem, Israel

The classification of the Ixodidae is still controversial and even generic status is disputed in some instances. Workers in this field all agree, that specific diagnosis is difficult and uncertain. COOLEY & KOHLS (1945) say in the introduction of their paper on *Ixodes*: "The ticks of the genus *Ixodes* have been one of the particularly troublesome groups...... 9 generic names have fallen into synonymy,". DELPY (1936) working on *Hyalomma* stated: "Il est presque impossible de determiner les femelles......". ZUMPT (1939-1942) revised the genus *Rhipicephalus* and noted the variability in specific characters. MINNING (1934) revised the genus *Boophilus*. He increased the number of species known till then from 6 to 16, added 2 n.ssp., and 3 n.sg. The genus *Haemaphysalis* was summarized by NUTTALL in 1915.

In spite of all these revisions Gertrud THEILER, in het Presidential Address to the S.A. Biological Society in 1947 summarized the situation in the classification of ticks as follows: "The classification of ticks down to genera is relatively simple, but the identification of species is difficult, for within the genus, ticks are all built to the same plan... So that at the moment, the classification of most ticks is a matter of *personal opinion,* based on *personal experience...* For, given that the species of a genus are all built to the identical plan, the specific characters, are very unstable, and most variable".

All the above authors employed the same gross systematic characters, i.e. the form of the palps, scutum, stigma, first coxa and anal armature, as well as the colour of the scutum, the legs and palps. All these characters prove to be subject to large variation within any species, so that specimens of a single species exhibiting extreme deviation in any character, will often be assigned to a number of species. *Hyalomma marginatum* e.g. is determined by SCHULZE and DELPY by the small punctations of the scutum, *H. impressum* is determined by large and dense punctations. But the variation in both species overlaps, and the student has to rely on his personal experience and intuition according to G. THEILER. The same applies to the females of *H. dromedarii* and *H. schulzei*. DELPY stated in the first part of his Revision of the genus *Hyalomma* that he tried to breed *H. schulzei* on several occasions. He used large specimens of *Hyalomma* which had been collected on camels together with males which he assumed, on the basis of their external appearance to be *H. schulzei*. The male offspring which are easy to determine (because of the feminine type of their stigma) were invariably *H. dromedarii*.

The large variation in macroscopic characters was recognized by most workers (CUNLIFFE, NUTTALL, DELPY, ZUMPT). NUTTALL, realizing this fundamental fact on the basis of his study of laboratory bred specimens included three distinct species in *Haemaphysalis cinnabarina punctata.* These species can now be readily separated on certain constant microscopic characters. SCHULZE on the other hand working only with preserved material and relying on variable macroscopic characters split one species into many species and subspecies, e.g. specimens belonging to *H.savignyi* were determined by him as *H.savignyi, H.savignyi mesopotamium; H.anatolicum; H.lusitanicum; H.lusitanicum algericum; H.lusitanicum berberum; H.excavatum; H.aegyptium aegyptium brunnipes; H.pusillum. H.pusillum alexandrinum; H.depressum,* and he even included a subgenus *Hyalommina.*

During an attempt to classify the genus *Hyalomma* in Israel by ADLER & FELDMAN-MUHSAM (1946–1948) it became clear that entirely new characters should be established for the specific diagnosis of the Ixodidae. Since macroscopic characters are often inadequate and even misleading it was decided to look for microscopic characters in cleared and mounted specimens. The characters which were found to be stable and to give a reliable diagnosis for the genus *Hyalomma* were: the female genital aperture, the peristigmal hairs, the number of "tunnels" or ducts of glands in the anterior body of the scutum. The female genital aperture proved to be the most important character especially as females were hitherto difficult to determine. The form of the female genital aperture and the peristigmal hairs may in some species also be seen without clearing and mounting of specimens, but it should be noted that in the case of the genital aperture uncleared specimens do not reveal the same structure as cleared ones. This structure in unmounted ticks may be used in some cases for specific diagnosis, as DELPY has shown (1949), but this method is limited in its application and it is always preferable and surer to examine mounted specimens.

The above method facilitates rapid definitve diagnosis of the females of *H.dromedarii, H.schulzei, H.marginatum, H.savignyi* and *H.impressum* which was impossible under the old system.

Further work proved that this method is also appliable to other genera of the Ixodidae, i.e. *Amblyomma, Dermacentor, Rhipicephalus, Haemaphysalis.*

It is interesting to note that chaetotaxy has not hitherto been used for specific diagnosis in Ixodidae, though differences in the pilosity of the peristigmal area, the trochanters and scutum are useful for diagnostic purposes.

In a revision of the Eastern Mediterranean species of the genus *Haemaphysalis, H.cinnabarina punctata* was shown to be a distinct species as the females genital aperture is different from that of *H.chordeilis (? = cinnabarina).* Furthermore, specimens belonging according to NUTTALLS description of this subspecies were classified into 3 species, *H.punctata,* s. str., *H.otophila* (Schulze) and *H.cretica* (Senevet). This latter species was described by SENEVET and CAMINOPETROS (1936) as a subspecies of *H.punctata* or *H. cinnabarina.*

The few species of *Dermacentor* and *Amblyomma* of the New World which Dr KOHLS kindly put at our disposal, *D.andersoni, D.occidentalis, D.parumapertus, D.variabilis, D.albipictus, A.americanum, A.maculatum* and *A.cajennense,* were also easily determined by this method (FELDMAN-MUHSAM 1951)

The method is also useful in the difficult genus *Rhipicephalus.* Differences in the shape of the females genital aperture are sufficient in the species studied; i.e. *R.sanguineus, R.bursa, R.appendiculatus, R.capensis, R.simus, R.evertsi.* The peristigmal hairs are present in *R.evertsi* and *R.bursa,* but not in the other mentioned species.

A study of the widely distributed species *R.sanguineus* led us to the conclusion that this is not a homogenous species but contains two distinct species readily distinguished by the genital aperture of the females and on the characters of the larvae and nymphs. This conclusion was confirmed by a study of laboratory bred material.

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DISCUSSION

Mr. **Galliard** congratulates Mrs. FELDMAN-MUHSAM on her valuable work.

THE SPECIES OF PORTUGUESE PHLEBOTOMUS

by
J.FRAGA DE AZEVEDO and A.TEIXEIRA FEIJÓ COLAÇO
Lissabon, Portugal

Summary

The importance attached to the study of *Phlebotomus* in Portugal is justified since such insects have been accused of disseminating the Leishmania of Kala-azar – a widely dispersed disease in the whole country. The species of *Phlebotomus* reported in Portugal up to the present date, are mentioned and also include the ecology of *Phlebotomus perniciosus* – the species most widely distributed in this region.

Finally the rôle of *Phlebotomus* is appreciated in the part they play in the transmission of the Leishmania of Kala-azar, taking in consideration its biology, the incidence of the disease and the percentage of the dogs – their natural reservoirs – infected.

FACTORS AFFECTING THE EFFICIENCY OF THE MITE-VECTOR OF COTTON RAT FILARIASIS

by

D.S.BERTRAM

London, Great Britain

The blood-sucking mite *Bdellonyssus bacoti* (syn. *Liponyssus bacoti*) is the vector of Litomosoides cavinii, the filarial worm parasite of the cotton rat, Sigmodon hispidus (Williams & Brown, 1946). This material has now been established as a laboratory strain in numerous institutes. The present paper reviews some of the writer's researches on the efficiency of the vector during the past five years. His observations were begun at the Liverpool School of Tropical Medicine, and are continuing at the London School of Hygiene and Tropical Medicine.

One aspect of the efficiency of a vector is the readiness with which it developes infective forms of a parasite after feeding on an infected host. The percentage infection rate for infective forms of the filarial worm in the mite is the criterion of vector efficiency considered in this paper. These infection rates varied from 8 to 98 per cent in a series of over 50 experiments in each of which a batch of mites was allowed to feed on an infected cotton rat and dissected two weeks later for the infective stages of the worm. This wide range might have had its explanation in lightly infected cotton rats causing low infection rates in the mites and heavily infected cotton rats inducing correspondingly high infection rates. This is partly true but the relationship is not a simple linear one. The present paper indicates some of the factors which have to be considered when attempting to understand the variable efficiency of this vector.

It is relevant to know something of the filarial infection in the cotton rat. The adult worms occur in the pleural cavities of the rat. Sheathed, non periodic, microfilariae appear in the peripheral blood about 50 days after transmission. If the rat is exposed to infection on one day only the blood infection lasts about one year. In these simple infections the microfilarial density may be consistently low (less than 100 mf./cu.mm.) throughout the year. Something like one to five female worms and some males would be present in the pleural cavities. Larger numbers of females result in heavier densities of microfilariae which may reach a peak of, say, 600 or 800 mf./cu.mm., or even higher, about 150 days,after the blood first becomes positive. Thereafter, the numbers decline. About the end of the year, few microfilariae occur and the blood may become negative. The adult worms also undergo degenerative changes and all may be dead and encapsulated about the end of the year or later. A cotton rat may, therefore, outlive its worm infection (KERSHAW and BERTRAM, 1946; KERSHAW, 1949; and BERTRAM, 1950). But one infection does not impart complete immunity to re-infection. Superinfection is possible

either at widely spaced intervals or virtually continuously (BERTRAM, 1950 und unpublished observations). Correspondingly extended blood infections result. The microfilarial peaks may be identified in well spared re-infections but in continuous superinfection peaks are obscured. Superinfections persist until the death of the host.

In our experience, simple infections of low microfilarial density arise from a small adult worm population but large numbers of adults do not produce proportionately heavy microfilarial counts. The factors at play appear to affect superinfections as well since, although large numbers of adults may mature progressively over a long period of time, a tentative figure of about 2000 mf/cu.mm. seems to be about the limit for microfilariae in the peripheral blood. Reduced productivity in individual female worms may account in part for the discrepancy between adult and microfilarial populations in heavily infected cotton rats.

It is against this background of different types of infection of the cotton rat that we have to consider the factors which might have been responsible for the infection rates in the mite varying from 8 to 98 percent. (BERTRAM, 1950).

The observations were made over nearly three years. It is possible that the mites varied in their susceptibility to infection, or that some experimental bias affected the results at certain times, possibly seasons, during this long period. There is little or no evidence of correlations of this nature.

It is convenient to note next the infection rates induced by cotton rats harbouring multiple infections as a result of superinfection. Two cotton rats with high microfilarial counts (1000 or more mf./cu.mm.) following over six months of continuous exposure ro re-infection induced infection rates in the mite of 8, 21, 22 and 39 per cent. On the other hand, another cotton rat subject to three transmissions on single days at intervals of 8 and 4 months was consistently heavily infective to the mites. The infection rates in mites from this cotton rat were 73, 85, 88, 90, 93, 95 and 98 per cent in seven observations spread over a year. The infection rates of 85 and 98 per cent were obtained when the rats count was over 1000 mf/cu.mm. The remaining results occurred in association with counts of 730 mf/cu.mm. or less. These cotton rats present the problem of rats with high microfilarial counts being either slightly or highly infective to the vector. The explanation appears to rest in the intensity of superinfection in the vertebrate host. It would be conceded by many workers that, in helminth infections, infection of the vertebrate host with the parasite stimulates host-reaction with adverse effects on the parasite. The results from these different types of superinfection in cotton rats suggest that some loss of infectivity in microfilariae developes as the adult worm burden and the intensity of host-reaction is progressively increased. Interaction of antibody with microfilariae could be the cause; but it may well be that primary effects on the parent worms and their developing embryos is involved.

We turn now to consider the infection rates in mites infected from cotton rats harbouring simple infections (that is, rats infected on one day only). The

range in this case is 11 to 86 per cent. Here high microfilarial counts are less infective to the mites than would be expected by comparison with the infectivity of low counts in the cotton rat. The infection rates increase rapidly to about 60 per cent as the count increases to 100–200 mf/cu.mm. But beyond this density, even up to 1200 mf/cu.mm., the infection rates do not exceed 86 per cent. Furthermore, there is a distinct trend for infection rates to be greatest in mites infected from cotton rats about the 150th day of their blood infections. And this is so, even although some of these cotton rats had light infections (less than 200 mf/cu.mm.) while others were between this density and nearly 1000 mf/cu.mm. This relationship of age of infection and infectivity appears to be important; it is apparent graphically, and statistically when survival rates of the mite, inherent differences in rats, and microfilarial density are taken into account as well.

It does, incidentally, confirm that variable susceptibility of the vector to infection and experimental error are unlikely to be wholly adequate explanations of the wide range in the infection rates. If they were, this quite independent relationship with age of infection in the rat could hardly have arisen. These relationships with age and density of infection in the rat could be accounted for by assuming that mites do not ingest, or retain, microfilariae in numbers proportionate to the blood count; that mites resist infection beyond a certain limit; that microfilariae fail to develope if overcrowded in the mite; or some combination of these possibilities. But such explanations would not account for superinfected cotton rats of similar high microfilarial density being, as already discussed, either slightly or highly infective to the mite. If, however, we attribute the reduced infectivity of heavy simple infections of the cotton rat to a host-reaction effect on the microfilariae more intense than in light simple infections, it is possible to extend this conception to account for the apparently anomalous results in the infectivity of multiply infected cotton rats which, as discussed above, differed in the frequency and duration of their superinfections. There are grounds for not disregarding the other factors entirely. Most mites ingest many more microfilariae than ever reach the infective stage. A proportion of these may well fail to develope for reasons other than an inherent incapacity to do so.

A characteristic of this material is that although certain relationships have been identified there has been a considerable range about mean values expressing the trends of these relationships. Part of this is undoubtedly due to intrinsic liability to variation in the complex interrelations of three biological entities, part to sampling error. But recently (BERTRAM, unpublished observations) it has been found that the environmental conditions prevailing during the infecting meal (a period of 24 hours) can affect considerably the ultimate infection rate in the mites. Thus, three cotton rats, at 18° C and 45 per cent R.H., induced infection rates of 58, 64 and 75 per cent in the mite. Nine days later, with the same rats at conditions of 24° C and 80 per cent R.H., the infection rates proved to be, respectively, 70, 90 and 98 per cent. On the second occasion the microfilarial counts in the rats were approaching double the ini-

tial counts. Increased microfilarial density with increased environmental temperature has been reported for this infection by KERSHAW (1949), who suggests that vascular adjustments are concerned. In the present experiments, the greater numbers of microfilariae at the second infecting meal may have much to do with the higher infection rates obtained in the mites. But this may not be the whole explanation.

Now, in the work discussed above, which extended over three years, the infecting meal was provided at room temperatures and humidities. The results may have been affected by differences in these conditions from time to time. The absence of correlation of infection rates with seasons indicates that severe seasonal fluctuations in environment were buffered by the insulating effect of buildings with controlled heating. Furthermore, on several occasions two or more cotton rats with different histories of infection were set up at the same time and mites were then released on them; the results obtained were thus derived from parallel experiments subject to identical conditions. In parallel experiments, complex superinfections of the cotton rat with microfilaria counts of 1000 mf/cu.mm. induced infection rates of 8 and 21 per cent in the mite when, at the same time, infection rates of 36 to 61 per cent were obtained in mites infected from three simple infections of 53 to 400 mf/cu.mm., On six other occasions over nine months, the multiply infected cotton rat exposed to three widely separated transmissions, and with counts of over 1000 mf/cu.mm, falling to 486 mf/cu.mm. in the period, induced infection rates between 85 and 98 per cent; in parallel experiments nine simply infected rats, despite blood infections of 39 to 798 mf/cu.mm., induced infection rates in the mite between 50 and 75 per cent. These consistent results in parallel experiments help to confirm that differences in the infectivity of different types of infection in the cotton rat are real. Clearly, however, some of the variation characteristic of this material can be eliminated by improved standardisation of environmental conditions during the 24-hour infecting meal. For various reasons, it is not generally practicable to reduce this period.

This review indicates that the readiness with which the mite becomes infected with infective forms of the worm is subject to several factors, among which the magnitude of infection and the multiplicity of reinfection of the cotton rat appear to play a part. Animals exposed to superinfection in the laboratory simulate what must be the usual state in natural infections. Further investigations with this material on simple infections and superinfections of laboratory origin are in progress. From such studies we may gain a better understanding of the factors which influence the efficiency of vectors in the field and, in turn, the epidemiology of arthropod-borne diseases under field conditions.

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DISCUSSION

Mr. **Webb** asks whether conditions in human malarial infection can be compared with those in the cotton-rat.

Mr. **Bertram** gives some examples showing in how far this comparison is justified.

Mr. **Gordon** points out the importance of these laboratory studies: they may explain difficulties encountered in the field, *e.g.* the discrepancies of low infection in man and high in *Chrysops* in loa-infection.

Mr. **Reid** comments on Gordon's remark and adds examples of *Malayi* infections in Malaya pointing in the same direction.

A METHOD FOR EVALUATION OF THE STRENGTH OF VENOM OF SPIDERS

by

A.SHULOV

Jerusalem, Israel

The venom of spiders has been known since historical times. The early observations of the influence of venom of *Latrodectus XIII–guttatus* Rossi, *Hogna narbonensis* Latr., and other alledgedly venomous spiders had been carried out by several scientists. These observations did not fully elucidate the problem as they described only fragmentary experiments upon various animals with very primitive techniques.

In the beginning of the century, several authors started to prepare solutions of the venom collected from the excited spiders, from their macerated poisonous glands and from various macerated parts of their bodies including eggs. This was necessarily done in order to eliminate the factors which caused the variations in the effect of the bites upon the experimental animals. The strength of venom has been ascertained through injections of suspension calculated to a certain fraction of the venomous gland. VELLARD (1936) worked out a first precise method for the evalution of venom by extracting the venomuos glands, drying them and diluting the pulvered residue in physiological saline.

But, as VELLARD already pointed out (1936), the effect of the diluted venom differs greatly from that of the direct bite. He demonstrated this fact with the differences of the speed of dying by animals directly bitten compared with the speed of dying of those injected with a suspension of the venomous glands. The symptoms of intoxication change or become feebler, and noticeably defered.

Other authors continued to experiment with direct bites. BERG (1936) used adult females of *Latrodectus mactans* Fabr. fed simultaneously. HERMS and others (1936) worked with a simple device which consisted of a glass tube and a bolt. The spider was put into a glass tube and the bolt pushed in towards the spider which forced it to bite the experimental animal. A proper attention was given, by the above mentioned authors, as to the conditions under which the animals in the experiment had been bitten. The bites were administered into the same area of the shaved skin of the animal and the effects of the bites protocolled.

Working with local species of *Latrodectus*-spiders, I came to the conclusion that there is too wide a range of fluctuation of results where precise comparison of the strength of the venom is wanted. The same obstacle was encountered when I worked on the comparison of the strength of venom of the local scorpions. The following procedure was worked out. The scorpions were forced to sting twice each animal under experiment and every scorpion

was allowed to sting, in succession, five animals, stinging this way, ten times during a short period. The series of the bites were tabulated so that the results could be compared. Another series was carried out by the maceration of the poison glands and the evalutation of venom by injections. The results of these two series of experiments were identical as to comparative strength of venom, and enabled the compiling of a table of the comparative dangers of the local scorpions. The table is headed by *Buthus V-striatus*, (H.&.E.), *Prionurus bicolor* (H.&.E.) and followed by *Buthus judaicus* E. Sim., *Scorpio maurus* L. and *Nebo hierichonticus* E. Sim.

When it became evident that the influence of the venom diminished with each successive bite, a method was worked out to use the tenth, seventh, fifth and second bites administered to the rabbits combined with injections of diluted scorpion venom.

This procedure enabled the receiving of a powerful scorpion serum in a comparatively short period of time. As symptoms produced by venom were different in bites and in injections it was assumed that a component included in the venom ejected from the gland, might be lost in the injection.

The same method was applied to the spiders, first to the three local *Latrodectus*-spiders and then to other local spiders as follows: only female spiders were used, at least one week after last moult. The spiders were held in broad pincers in such a way that they could insert their jaws into the shaved skin of animals. Two bites were allowed in order to diminish the possible variation of venom ejection during each bite. The place of the bite was always the right side of the belly, 1 – 2 cm from the hind right femur. Each bite lasted for two or three seconds; in each case it was necessary to pull the spider backwards in order to withdraw its jaws from the skin of the bitten animal.

Each spider was allowed to bite 2 to 5 animals successively, with short intervals between each bite. The experiments were carried out on field mice (Microtus guentheri), white mice, and guinea pigs. The following results were received from the field mice; the figures in brackets indicate the number of animals bitten.

	in series	first bites	time of death hours
Latrodectus XIII–guttatus Rossi	26(34)	10(10)	7.3
Latrodectus revivensis Shulov	15(18)	6(7)	6.5
Latrodectus pallidus Cambr.	12(35)	7(11)	10.8

In this way, quite definite results of the comparative strength of venom were obtained.

This method also served for the evaluation of possible immunity in the animals which had been bitten and recovered (mainly from the last bites in series). It was possible to learn that there is a certain degree of immunity produced by bites in the field mice. Thus when 8 animals were bitten for the first time 7 of them died in first bites and 10 out of 14 in first and

second bites together. When bitten after two weeks the numbers were 5 dead out of 13 in the first bites and 5 out of 15 in the first and second bites together. In order to check the immunity developed under the influence of the bites of spiders of other species the experiments were arranged in the following way. *Latrodectus XIII-guttatus* and *Latrodectus pallidus* spiders were used. Two field mice were bitten by the same spider so that one received the first and the fourth bites and the other the second and the third. After two weeks one of the mice was bitten by a spider of the same species and another by one of the second species.

The results were as follows: First bitten by *L.pallidus* and then by *L. pallidus* again two were dead out of 8 experimented with. First bitten by *L.XIII-guttatus* and then by *L.pallidus* two were dead out of 11 animals. Field mice served as material. The lack of spiders did not allow the continuation of this work for obtaining sufficient results for statistical analysis. However the first impression was that a certain degree of immunity was likely to develop under the influence of bites of related species.

It must be mentioned that contrary to the gradual decrease of the toxical influence of the successive stings of scorpions, there is no such a clear cut gradation in the successive bites of the spiders. The amount of venom ejected by spiders seems to be less dependent on the stock already present in the tube of the venomous gland than that which takes place in the scorpions.

Using the above mentioned method some experiments were carried out upon several species of local spiders as *Chaetopelma olivacea* C.L.Koch, *Ilogna narbonensis, Eusparassus walckanaeri* Aud., *Lithyphantes paykullianus* Walck. and *Lithyphantes gerhardti* Whle. The experiments, although not sufficient for the present to draw any definite conclusions, allow nevertheless to establish a considerable toxity of Theridiid spiders in comparison with other families. In preliminary experiments with the *Lithyphantes*-spiders it appeared necessary to cut the skin and to force the spider to bite into the muscles. In this way it is intended to check all the local spiders, which by their bites, may be involved in causing troubles to human beings.

DISCUSSION

Mr. **Busvine** recalls the fact that first bites proved more fatal than subsequent ones, and asks if that is not better explained by assuming that the less susceptible victims survived rather than that they acquired immunity.

Mr. **Shulov** replies that the arrangement of the experiments was such as to exclude the existence of a simple selection of little susceptible victims.

BIOLOGICAL FACTORS OF TICKS (IXODOIDEA) OF THE ETHIOPIAN FAUNAL REGION IN RELATION TO HUMAN INJURY AND DISEASE

by
Harry HOOGSTRAAL
U.S. Naval Medical Research Unit 3
Cairo, Egypt

Introduction

As part of a visionary and far-reaching program of medical research, the United States Navy's geomedical studies in Africa and the Near East include field, laboratory, and literature investigations of ticks and tick-borne diseases. The speaker wishes today to mention the already-incriminated Ethiopian Faunal Region tick species and to summarize the status of biological information essential in planning a tick-borne disease prevention and control program for tropical and South Africa.

Actually general and specific knowledge of African tick-borne human diseases is pitifully meagre. Among medical and allied professions few persons are aware of which diseases may be present, which are vector species, or what problems are involved. Identification of many African ticks is difficult, diagnosis of tick-borne diseases is often inexact or impossible in the absence of specialized laboratory facilities, and treatment methods have yet to be perfected. What little biological data we do have for African ticks come almost entirely from veterinarians. Many more tick species await proof of their relation to disease.

But the threat of human tick-borne diseases is always present and poses a real problem under urban and field conditions for indigenous people, non-immune newcomers, and resident whites who ordinarily live under protected conditions. Until more extensive virological, rickettsial, and biological research can be practiced on the African continent, our knowledge of the epidemiology of tick-borne diseases will remain largely fragmentary. Even in Egypt, where medical research has been intensively undertaken for years, the U.S.Naval Medical Research Unit No. 3 with little effort has recently found. several pathogenic viruses and rickettsiae hitherto unknown there. We can only surmise what a rich fund of information awaits research in tropical and South Africa, and how many more tick-borne diseases will eventually be discovered there.

Tick-borne relapsing fever

Fortunately in relapsing fever we deal with only one tick species, the eyeless tampan, *Ornithodoros moubata* (Murray 1877). A closely related species, *O. savignyi* (Audouin 1827), is also slightly suspect but is not incriminated on evidence in nature. *O. erraticus* (Lucas 1849), a notorious North African vector, is known from central latitudes only from Senegal and by rare specimens from Kenya and French Equatorial Africa.

The disease and its principal vector occur over a large part of the Ethiopian Faunal Region. Though the primitive habitat of *O. moubata* may have been burrows of large wild animals, it has now thoroughly adapted itself to domestic conditions and is transported far and wide by human facilities. The tampan lives commonly in indigenous huts, also in white-race houses, and often in labor camps rest houses, military barracks, coffee houses, and corrals where it feeds on man and domestic animals. It burrows about an inch below the surface of the ground in warm, dry places, often near fire, or hides in cracks, dust, walls or roofing. Areas of heavy forest and rainfall are seldom inhabited, but otherwise the tick is more or less closely associated with age-old and modern trade routes. Present day labor-importing methods and rapid transportation are particularly favourable for its spread. The tampan takes a quick meal from its host, then retires to its hiding place to digest the blood and lay its eggs. The tick's long life with or without food, its effective camouflage, and its ability to transmit the causative spirochete hereditarily via the egg to its progeny increase control difficulties.

Stationary human communities often develop considerable immunity to the disease, but non-immunes quickly succumb; therefore laborers, immigrants, and visitors should be especially watched. New labor from infected areas requires special precautionary measures in order to avoid epidemics.

Chemical control of buildings and corrals, for which gammexane is recommended, considerably reduces tampan populations but seldom kills the entire number present. Reintroductions are frequently rapid. Proper construction and maintenance of floors and walls, substitution of beds and chairs for pallets on the ground, placing beds and hanging clothes away from walls, exclusion of domestic animals from human quarters, and inspection of new laborers' personal effects help to control the vector. East African military buildings have been especially constructed to eliminate the tampan. Travelers' quarters should be rigidly inspected and sleeping in infested indigenous huts should be avoided. Away from buildings one need have little fear of acquiring tampan bites.

Boutonneuse fever (South African tick-bite fever, Abyssinian typhus, Kenya typhus, etc.).

Boutonneuse fever in its various epidemiologic forms is widely distributed through Africa and southern Europe, and presents a rather more complex problem. Several tick species of various biological characteristics are involved, some of which attack man in the field and others which attack "stay-at-homes". British and Italian military research and veterinary investigations have supplied much of our knowledge of this disease in Africa, except in North Africa where the Pasteur Institutes have done considerable work.

In urban and rural communities throughout Africa two domestic dog ticks, *Rhipicephalus sanguineus sanguineus* Latreille 1806 and *Haemaphysalis leachi* (AUDOUIN 1827), transmit the causative rickettsia to man. All stages of the former species often live on dogs, but immature stages of the latter usually live on rodents or in mammal nests. These species are additionally

dangerous in that they are capable of passing the organism to their progeny via the egg and the progeny are then able to transmit it to vertebrate hosts. Wherever dogs are kept care should be taken to prevent tick breeding in kennels and subsequent entrance into human quarters, and to eliminate rodents from houses and nearby gardens and fields.

Under rural and field conditions, *Rhipicephalus simus simus* KOCH 1844 transmits the disease. This tick, widely spread south of the northern deserts, infests dogs and all domestic animals, and a variety of small ruminants, carnivores, and other mammals. Its immature stages feed on rodents which often occur in gardens and cultivated field edges. The adults climb on to tall grass awaiting a host and are not infrequently carried into houses. *R. pulchellus* GERSTÄCKER 1873 of East Africa, a suspected transmitter, also awaits hosts on tall grass and avidly seeks man in all stages, but normally lives on domestic and a wide variety of wild animals. It too is brought into habitations, and may be especially serious where wild game feeds near houses. *R. appendiculatus* NEUMANN 1901 is widely spread through those warm, humid parts of the continent that provide sufficient shrub cover for its protection, and increases greatly in numbers in rainy seasons. Like the other species, it infests a large variety of domestic and wild animals. In South Africa in warm, humid, shaded areas, *Amblyomma hebraeum* KOCH 1844 is an important vector in the immature stages, which usually frequent birds and small mammals. The adults are most serious cattle pests, and live on all domestic and a wide variety of wild animals. Some South African authorities even believe that any local species of tick may be incriminated there. *Boophilus decloratus* (KOCH 1844), has been accused on circumstantial grounds in West Africa. This "one-host" parasite attacks cattle, other domestic animals, antelopes, some other wild animals, and sometimes man. It ranges from the less arid areas of South Africa to 15° N latitude, and is present at all altitudes regardless of temperature provided shade and moisture are available. *H. rufipes rufipes* (KOCH 1844), a more or less common species under a great variety of temperature and humidity conditions throughout the Region, is a parasite chiefly of domestic animals. The speaker considers it particularly suspect in drier areas where cattle are maintained, and in Egypt and Arabia, at least, finds it not uncommonly attacking man in vegetated desert areas. *Ornithodoros moubata*, which we have already discussed, has been experimentally infected.

We may then expect to find one or more potential transmitters under almost any faunal, floral, temperature, humidity and altitude condition in the Ethiopian Faunal Region, especially in association with dogs and cattle, and sometimes with rodents or wild animals. The practice of proper veterinary control measures, dog-tick control measures, care to avoid tick bites in the field, search for attached ticks on return from the field, and often grass cutting and localized chemical control should be considered to control tick transmitters of this disease. Rodent control is indicated for certain tick species. Game control may sometimes be necessary on a considered basis.

Q Fever

The distribution of this rather recently discovered disease, which authorities now consider to be probably world-wide, is poorly known in the Ethiopian Faunal Region where only South Africa, Ruanda-Urundi, and French Equatorial Africa have so far been definitely involved. The focus among pastoral peoples of Ruanda-Urundi is an especially severe one and epidemics resulting in ten percent mortality have been reported. In North Africa the disease is common. Epidemiological factors are still poorly understood, but ticks apparently play an important role in maintaining and perpetuating the disease in nature.

The common dog ticks which we have already discussed, *Rhipicephalus s. sanguineus* and *Haemaphysalis leachi*, are incriminated in Q fever transmission. A variety of *H. leachi* from cattle has also been found infected. *Ornithodoros moubata* is an excellent experimental transmitter but has not yet been found naturally infected. On cattle and other domestic animals several species are already incriminated. *A. variegatum* (FABRICIUS 1794) is exceedingly common on cattle and present on all domestic and many wild animals under numerous conditions north of the Union of South Africa. Its immature stages live on smaller domestic and wild animals, and on birds, and sometimes attack man. *Hyalomma excavatum* (KOCH 1844) we need fear only along the drier northern borders of the Ethiopian Faunal Region, where it is also a domestic animal and wild ruminant parasite whose immature stages attack many smaller animals, rodents, birds, and lizards. Semidesert conditions are favourable for this species and all stages bite man, sometimes frequently. *Otobius megnini* (DUGÈS 1883), on the other hand, after having been introduced from North America, where hereditary transmission of the disease organism in it has been demonstrated, is established in dry parts of South Africa and spottily elsewhere. Uniquely adults do not feed but immature stages attach usually in the ears. This species is almost entirely confined to domestic animals, ostriches, and sometimes to man in Africa.

For the tick and other phases of transmission of Q fever, the great cattle-breeding areas of Africa are particularly suspect and extensive serological tests for the disease should be made in these places. Veterinary control methods, sanitary measures, personal caution, localized chemical control, and grass cutting are here again indicated. Cattle are often transported or moved great distances in Africa and when possible should be checked to prevent introduction of tick species that may be able to establish themselves.

Tick paralysis

We know this syndrome only by single reports from Italian Somaliland and South Africa where young and adult Africans have been attacked by *Rhipicephalus s. simus*, a tick already discussed in the section on boutonneuse fever. The condition is undoubtedly more common than present records indicate, and any case of rapidly ascending paralysis or partial facial paralysis should be considered in relation to ticks. In localized areas, as for instance Italian Somaliland, there is some chance that this affliction is common

enough to warrant measures for controling *R. s. simus* on dogs and domestic animals, and by rodent control in and near living quarters.

Tick injury

Over a dozen other tick species bite man with more or less painful aftereffects, some of many years' duration. Bites may be acquired under almost every conceivable situation in Africa.

In conclusion it should be emphasized that tick-borne diseases in the Ethiopian Faunal Region pose the following serious problems: (1) the four recognized medical entities are not only poorly known but undoubtedly represent only a part of the actual number present, (2) there assuredly exist many undiscovered tick vectors, (3) evaluation must be made of the rôle of domestic and wild animals reservoirs and of ticks in relation to other mechanisms of transmission, and (4) the biological and ecological characteristics of vector species must be considerably elucidated before there can be a promise of effective control and prevention.

DISCUSSION

Mr. **Galliard** enquires whether speaker has witnessed the transmission of Borrelia duttoni by lice.

Mr. **Hoogstraal** says that he lacks personal experience on the subject.

ABOUT THE CULICINAE OF THE PORTUGUESE TERRITORIES IN AFRICA

by
AMADEU TEIXEIRA FEIJÓ COLAÇO
Lissabon, Portugal

Summary

Mosquitoes have not been studied intensely in the protuguese territories in Africa and it seems interesting to present a review of the knowledge acquired by those that have worked in this field of entomology.

This work is merely a compilation of the existent knowledge on the taxonomic and biological aspects of mosquitoes in the Portuguese territories. Lists by provinces of the species found are given.

SUR L'ICONOGRAPHIE D'HOPLOPLEURA ACANTHOPUS (H. BURMEISTER 1839) G. ENDERLEIN 1904. [ANOPLURA]

par
Robert Ph. DOLLFUS
Paris, France

Cette espèce, générotype d'*Hoplopleura* G. Enderlein 1904, assez commune en France, a été souvent signalée et décrite d'Europe et d'Amérique du Nord (Etats Unis et Canada) sur divers Muridae (Microtinae, Murinae, Neotominae) et exceptionnellement sur un Insectivore (Crocidura) *).

Dans sa révision de l'espèce, G. FERRIS (1921 p. 63-67, fig. 33 C, 35A-D) a donné une liste des références bibliographiques et iconographiques complète jusqu'à environ 1920. Il faut y ajouter: Ludwig FREUND (1935 p. 16, fig. 67-69), O. JANKE (1930 p. 5, fig. 9-11; 1938 p. 69-70, fig. 20a-e), Eugène SÉGUY (1944 p. 435-436, fig. 687-689).

Si l'on compare les figures publiées, l'on remarque des différences morphologiques quelquefois assez étendues pour que l'on puisse douter de la conspécificite de tous les specimens rapportés à cette espèce.

H.FAHRENHOLZ (1916 p. 26, fig. 21a-c; 1916 p. 92-93) a distingué, en Allemagne, une forme type et deux variétés (*aequidentis* et *edentulus*) qui diffèrent principalement par la forme des pleurites du 3ème segment abdominal.

La forme type a pour hôte, d'après FAHRENHOLZ: Microtus arvalis Pallas; la var. *aequidentis*: Pitymys subterraneus (Sélys Longchamp); la var. *edentulus*: Evotomys rutilus (Pallas). La var. *americana* V.L. Kellog et G.F. Ferris 1915 semble avoir été abandonnée par G.F.FERRIS (1921 p. 63-64) lui-même.

Il s'en faut de beaucoup que l'on puisse attribuer exactement à une des trois formes de FAHRENHOLZ tous les individus jusqu'à présent figurés. Je figure ici (fig. 1-4) des individus que j'ai récoltés sur un Microtus arvalis Pallas ♀ aux environs de Paris et, pour comparaison, je reproduis des figures (fig. 5-9) empruntées à H.FAHRENHOLZ (1912) et L.FREUND (1932).

On peut se demander s'il existe: des races géographiques, phénotypes indépendants de l'hôte, dépendant seulement de la région, ou des races particulières à un hôte déterminé ou à un groupe d'hôtes, ou encore si les variations sont purement individuelles et peuvent se retrouver, d'une part, chez des individus d'une même lignée vivant côte à côte sur un même hôte et, d'autre part, dans des régions éloignées les unes des autres, dans l'aire

*) Deux autres espèces seulement sont connues d'Europe centrale et occidentale: *longula* (L.G.Neumann 1909) et *affinis* (H.Burmeister 1839).

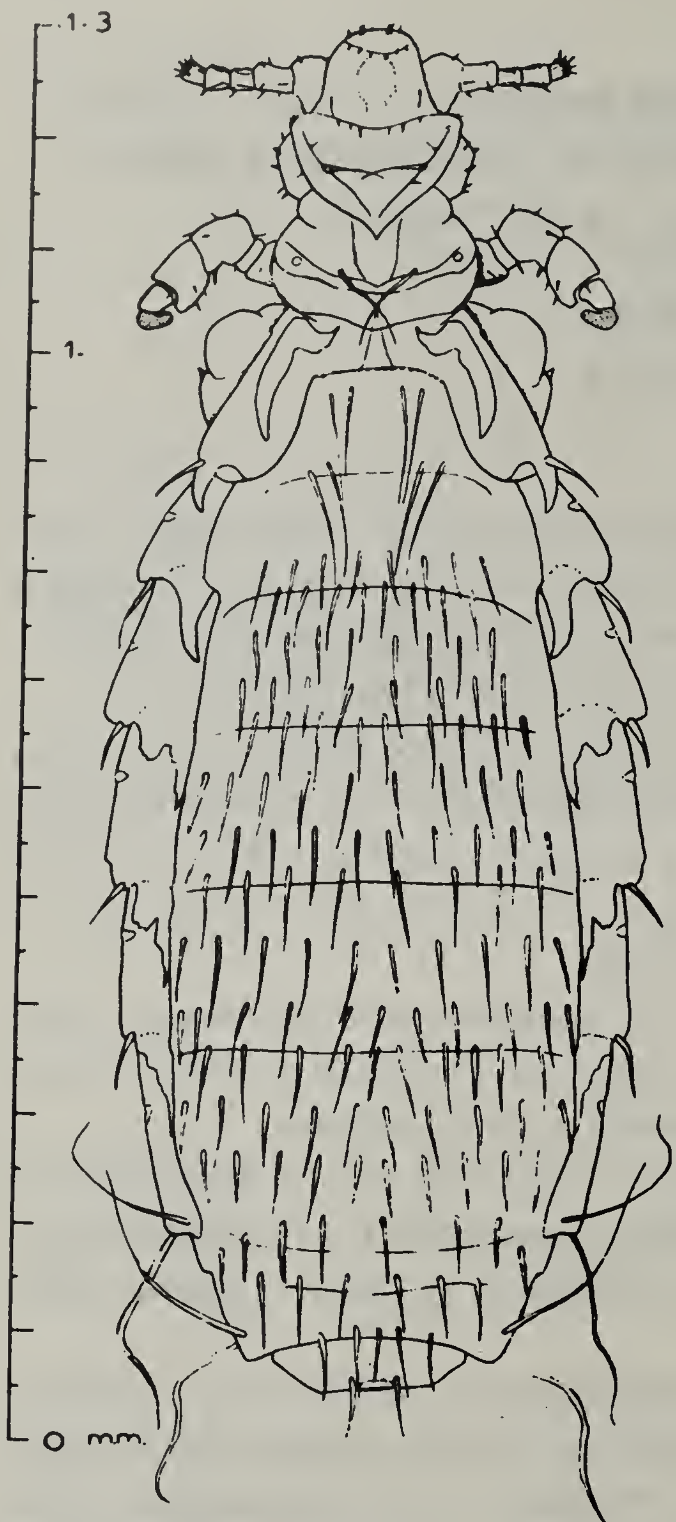

Fig. 1. *Hoplopleura acanthopus* (H. Burmeister 1839) ♀, face dorsale. Sur Microtus arvalis Pallas ♀; Joinville (Seine) 7.4.1944.

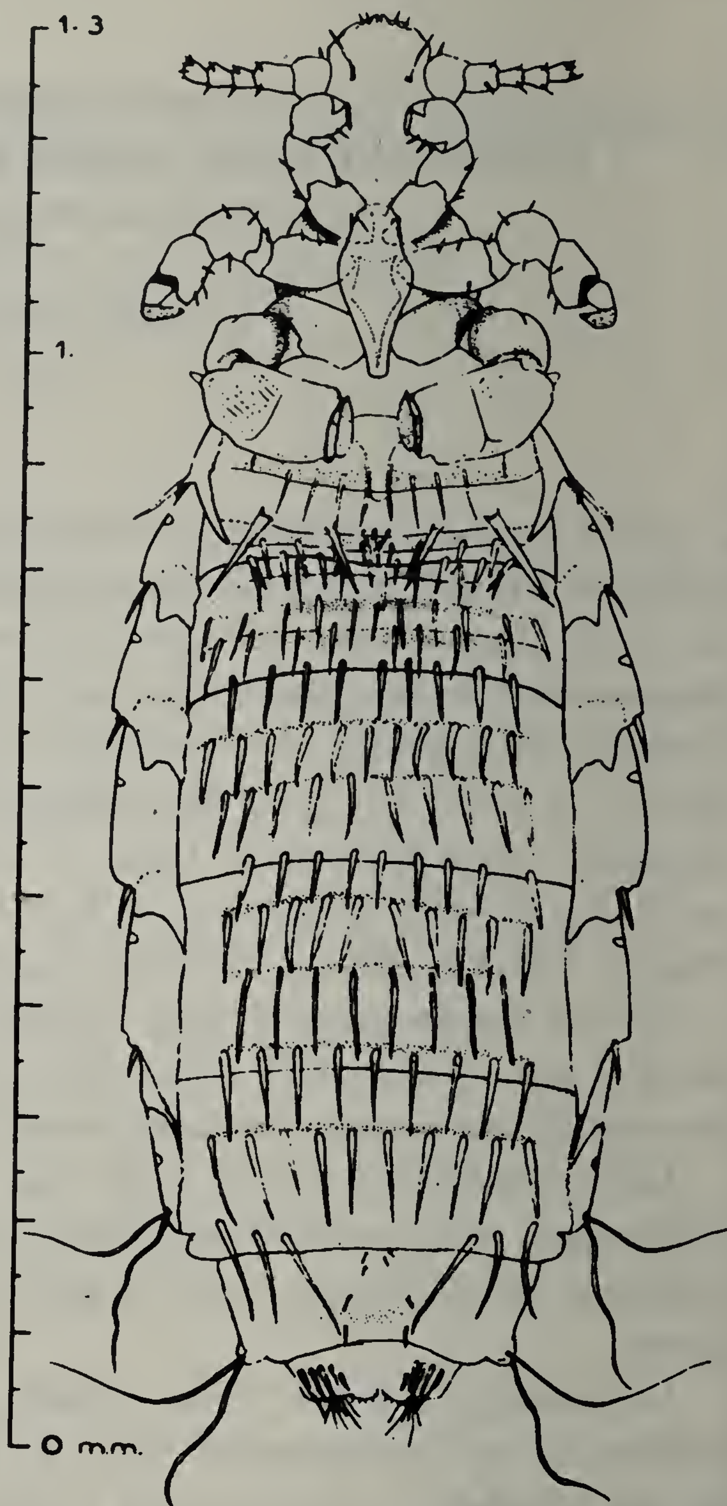

Fig. 2. Id. ♀ face ventrale; même provenance.

de distribution de l'espèce. Les matériaux dont je dispose ne me permettent pas encore de donner une réponse à ces questions.

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DISCUSSION

Miss **Clay** asks which were the hosts of FAHRENHOLZ's parasites.

Mr. **Dolfuss** answers that they belonged to the genus Microtus, he himself examined.

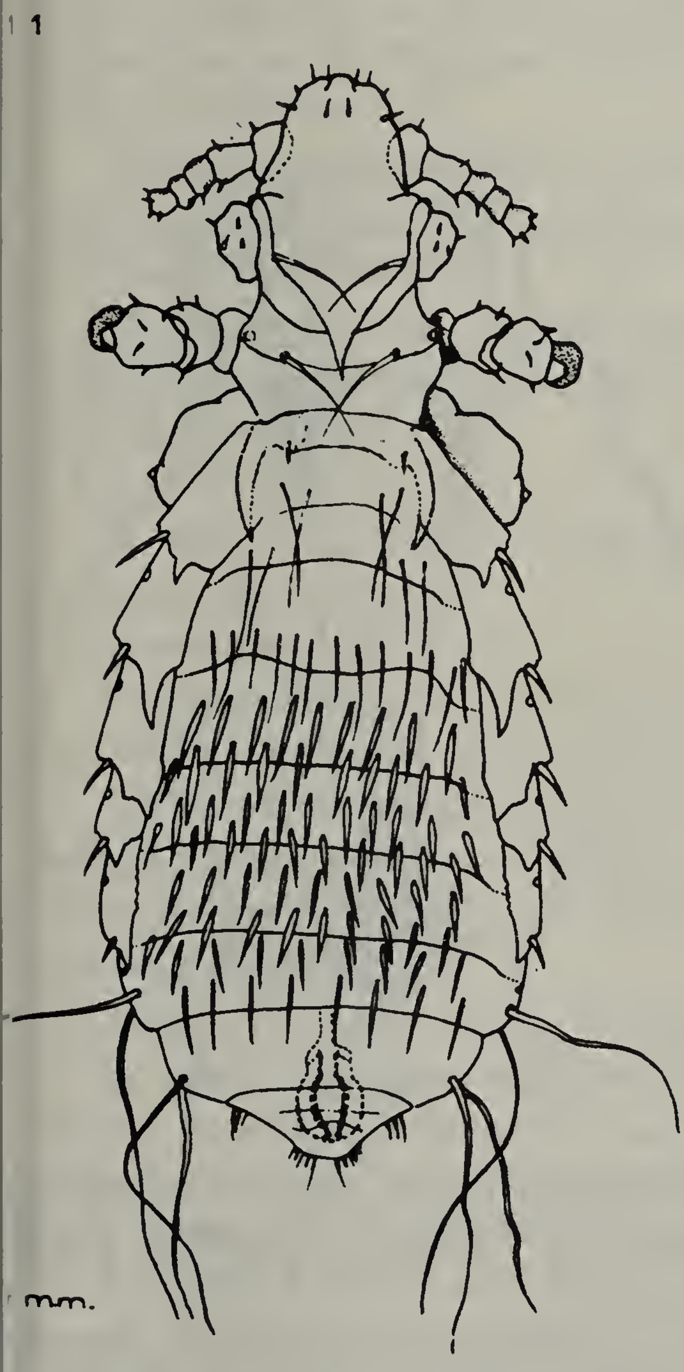

Fig. 3. Id. ♂ face dorsale; même provenance.

Fig. 4. Id. ♂ face ventrale; même provenance.

Fig. 5

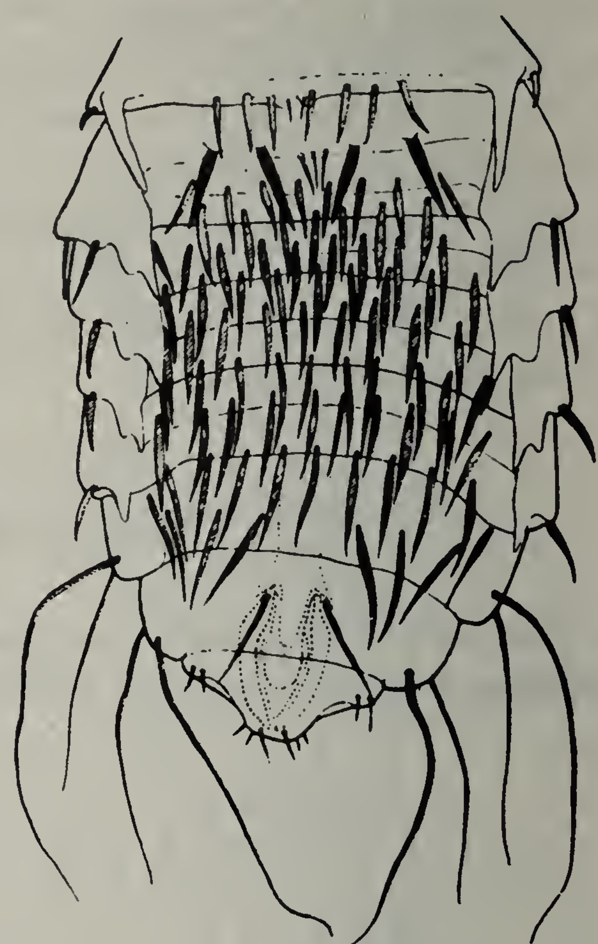

Fig. 6

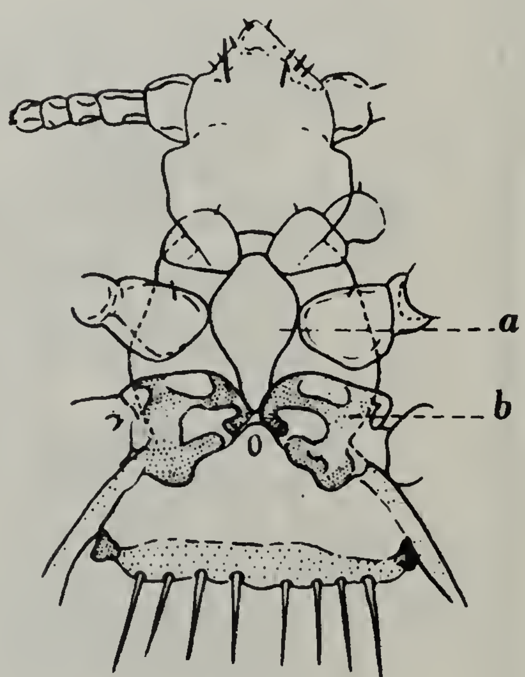

Fig. 7

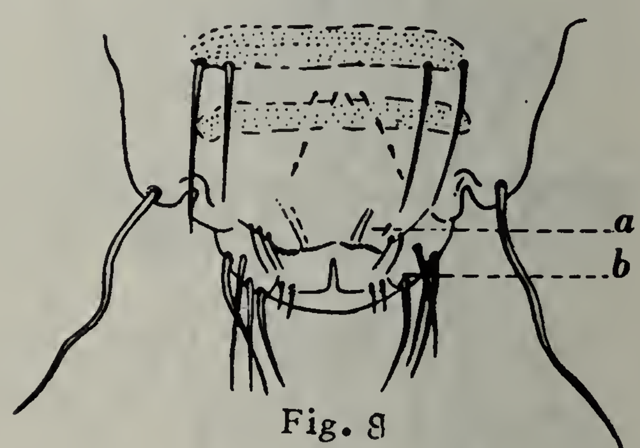

Fig. 8

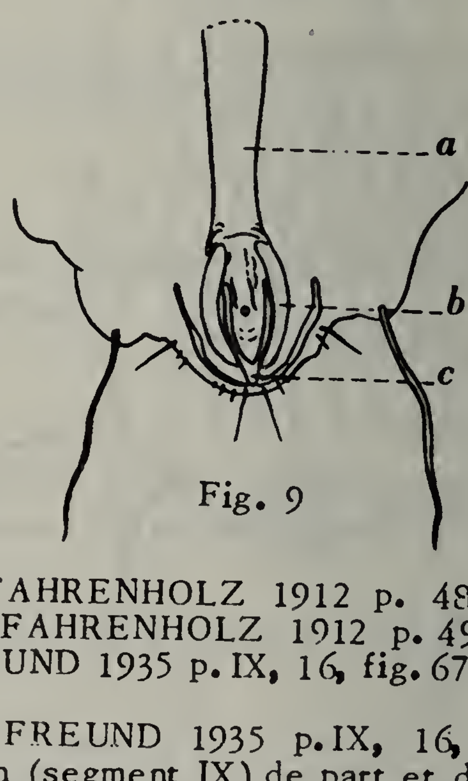

Fig. 9

Fig. 5. Id. ♂, face dorsale (d'après H. FAHRENHOLZ 1912 p. 48, fig. 18).
Fig. 6. Id. ♂, face ventrale (d'après H. FAHRENHOLZ 1912 p. 49, fig. 19).
Fig. 7. Id. ♂, face ventrale (d'après L. FREUND 1935 p. IX, 16, fig. 67). *a* sternum, *b* coxa de la 3e paire de pattes.
Fig. 8. Id. ♀, face ventrale (d'après L. FREUND 1935 p. IX, 16, fig. 68). *a* gonapophyse, *b* lobes postérieurs du telson (segment IX) de part et d'autre du segment X.
Fig. 9. Id. ♂, face dorsale (d'après L. FREUND 1935 p. IX, 16, fig. 69). *a* plaque basale de l'appareil copulateur, *b* paramère, *c* pseudopenis.

REMARQUES SUR LES PAEDERUS VESICANTS (COLEOPTERA STAPHYLINIDAE)

par
Jean THÉODORIDÈS
Banyuls s/Mer, France

La question des Coléoptères Staphylinides vésicants du genre *Paederus* a déjà fait l'objet de nombreux travaux dont les principaux sont cités par ALLARD (1948).

Nous rappelons ici pour mémoire que ces Insectes répandus en Europe, Afrique, Asie, et Amérique peuvent causer des dermatites vésiculeuses lorsqu'ils sont écrasés sur la peau, et des accidents oculaires s'ils entrent en contact avec les yeux.

Nous avons récemment fait en France des essais qui ont pu confirmer les propriétés vésicantes de *P.fuscipes* Curt. chez l'homme et le cobaye, et ont mis en outre en evidence l'action vésicante de *P.riparius* L. et *P.rubrothoracicus* Goeze sur l'homme et le cobaye, ainsi que celle de *P.littoralis* Grav. sur ce dernier.

D'après nos expériences, celles des auteurs, et les cas spontanés nous distinguerons 3 stades dans l'évolution des dermatites à *Paederus:*

1. Stade érythémateux:

Il débute environ 24 heures après le contact avec le Coléoptère, et dure environ 2 jours; il est caractérisé par l'apparition d'une plaque rouge plus ou moins importante.

2. Stade vésiculeux

Il dure 2 à 3 jours et consiste en la présence de très petites vésicules remplies de sérosité.

3. Stade squameux

Il dure une huitaine de jours et est caractérisé par l'apparition d'une croûte suivie d'exfoliation épidermique.

La cicatrice laissée par la lésion peut persister plus d'un mois. Pour le détail, nous renvoyons à notre travail (THÉODORIDÈS 1950) et nous nous bornerons à mentionner ici quelques problèmes qu'il serait intéressant de pouvoir résoudre:

1. Nature de la substance vésicante

Le corps chimique responsable des lésions n'a jamais été isolé par un chimiste, cependant, différents auteurs (en particulier GENEVRAY et collaborateurs) ont montré en faisant des broyats de *Paederus* dans divers liquides, que la substance vésicante était soluble dans l'eau, l'éther, le chloroforme, etc.

Certains auteurs ont prétendu que cette substance était de la *cantharidine,* mais ceci semble impossible, si l'on considère, d'une part, que ce dernier corps agit très rapidement après son application, et d'autre part, que les lésions qu'il crée sont très différentes (formation de véritables „cloques" sans érythème préalable).

2. *Mode d'action de la substance vésicante*

M. LECLERCQ et collaborateurs ont récemment montré que les venins d'Hyménoptères avaient une action vésicante due à certaines propriétés biochimiques (corps „thioloprivés" transformant les radicaux -SH de la peau en radicaux -SS).

Il serait intéressant de voir si la substance vésicante des *Paederus* possède ces propriétés que l'on peut mettre en évidence par des réactions simples.

3. *Possibilité d'immunisation*

Une auto-expérience récente consistant en une application de *Paederus caligatus* Er. s'est montrée entièrement négative, bien qu'elle ait été faite exactement de la même manière et dans les mêmes conditions que les essais antérieurs.

Cette espèce étant certainement vésicante, comme tous les *Paederus* étudiés expérimentalement jusqu'ici, nous avons pensé à la possibilité d' une immunité acquise, sans pouvoir cependant conclure catégoriquement faute de données suffisantes.

Ces quelques points montrent tout l'intérêt de ces Coléoptères dont l'étude concerne à la fois l'entomologiste, le chimiste et le médecin.

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DISCUSSION

Mr. **Bequaert** recalls his own experience on the subject of vesication by beetles. He observed an epidemic of the kind caused by the presence of large numbers of beetles.

PROBLEMS PRESENTED BY GLOSSINA PALLIDIPES AUSTEN IN KENYA COLONY

by

S.G. WILSON

Kabete, Nairobi, Kenya

Introduction

Glossina pallidipes is the most widely distributed tsetsefly in Kenya Colony and is the most important vector of trypanosomiasis. It occurs in every type of vegetation in Kenya from the dry Acacia-Commiphora semidesert scrub to the margins of rain forests, provided that riverine thicket is present to a greater or less degree and that the more upland areas are covered by broken clumps of vegetation.

This diversity of habitat complicates the problems connected with reclamation. In a brief paper of this nature only the problems connected with one of Kenya's fly belts can be outlined i.e. those of the Makueni fly belt in the dry eastern savannah of Central Province.

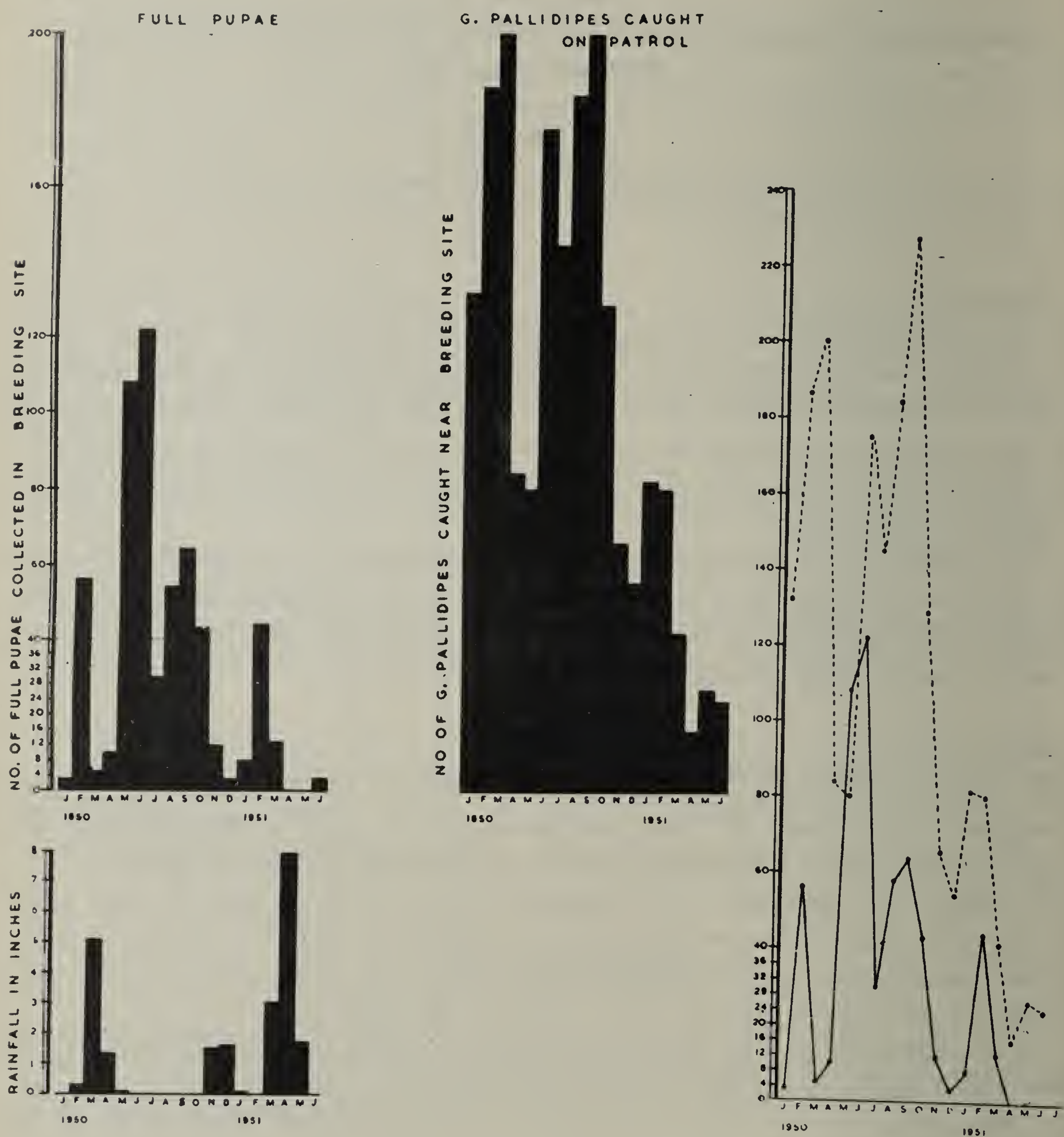
Makueni fly belt.

(a) *Situation.* This fly belt lies between latitude 1° 30' and 2° South and longitude 37°30' and 38° East and forms part of a much larger fly belt extending east of the Athi river and south of the Kiangini-Kikuuni rivers.

(b) *Climate & Vegetation.* The climate of this area is hot and dry, the maximum shade temperature varying between 80° F to 100° F and the minimum shade temperature seldom falling below 50° F. Rainfall averages 10" per annum in the east to 20"–25" per annum in the west.

The vegetation may be broadly classified as a complex Acacia-Commiphora-dry grass land association. On the higher areas on the western boundary at an altitude of 3500 to 4000 ft above sea level and with a rainfall of 20"–25" per annum the vegetation is varied, Combretum sp., Acacia spirocarpa, Lannea stuhlmannii, Commiphora pilosa, and Dalbergia melanoxylon being the dominants. Numerous other associated species occur such as Acacia subalata, A.pennata, A.mellifera, A.senegal, Albizzia sp., Ormocarpum kirkii, O.trichocarpus, Grewia sp., Erythrina burtii, Terminalia sp., and Fagara sp. In the lower country along the Kikuuni and Athi rivers, at an altitude of approximately 3000 ft, the rainfall is less, varying from 10" to 15" per annum. The vegetation is of the dry scrub-thicket type with, Acacia mellifera, A. pennata, Combretum exalatum, Salvadora persica, Sansevieria robusta, Grewia sp., Anisotes bracteatus, Cordia sp., Capparis kirkii thickets. Taller trees occur, especially along the river banks such as Acacia senegal, Acacia usambarensis, Piptadenia hildebrandtii, Delonix elata and Commiphora sp.

(c) *Fly distribution.* The three species of *Glossina* which occur within this fly belt are *Glossina pallidipes, G.longipennis,* and *G.brevipalpis,* but *G.*



pallidipes is by far the most important and widely distributed species. The main strongholds of this species are along the riverine thickets to the north, east and south, but dispersion and breeding takes place far remote from these riverine areas.

(d) *Problem.* The chief problem in this area is the location of the breeding grounds favoured by *"pallidipes"*. Although most flies are caught along the fringing bush of the rivers, breeding grounds are scattered both along the river banks and far inland and are most difficult to locate. The only striking exception to this rule is on the Kikuuni river where a small localized area has been discovered which may be regarded as an ideal breeding site for *"pallidipes"*. Searches have been made in this area each month over the past 18 months and the results are given in Table I.

TABLE I

Data collected from a riverine G.pallidipes pupae site during monthly searches over a period of 18 months.

	1950											
Month	J	F	M	A	M	J	J	A	S	O	N	D
(a) Full pupae found	3	56	5	10	108	122	30	58	64	43	12	3
(b) Empty pupae found	46	40	15	27	39	16	39	94	84	79	43	10
(c) Total	49	96	20	37	147	138	69	152	148	122	55	13
(d) Av.ground temp.2 p.m °C	24	24.7	24.9	23.6	24.3	23.9	21.9	22.7	24.4	25	25	24.1
(e) Av.Max. temp. °C	32.6	34.7	32.6	30.2	29.0	28.6	27.6	29.0	29.3	31.4	32.6	30.8
(f) Av.Min. temp. °C	14.8	15.4	17.5	16.7	16.1	12.2	15.6	9.9	14.3	15.1	17.7	18.9
(g) Rainfall in ins.	–	0.27	5.07	1.30	0.06	nil	nil	nil	nil	nil	1.5	1.6
(h) No. of fly caught in adjacent fly round	132	186	200	84	80	175	145	184	227	129	66	55
	1951											
Month	J	F	M	A	M	J	J	A	S	O	N	D
(a) Full pupae found	8	44	13	–	–	3	–	–	–	–	–	–
(b) Empty pupae found	45	60	32	–	7	5	–	–	–	–	–	–
(c) Total	53	104	45	–	7	8	–	–	–	–	–	–
(d) Av.ground temp.2.p., °C	25	25.8	25.7	22.7	22.8		–	–	–	–	–	–
(e) Av. Max. temp. °C	32.4	32.1	32.0	27.0	27.8	–	–	–	–	–	–	–
(f) Av. Min. temp. °C	14.3	16.0	18.3	18.4	17.7	–	–	–	–	–	–	–
(g) Rainfall in ins.	0.06	nil	3.01	7.92	1.65	nil	–	–	–	–	–	–
(h) No. of fly caught per patrol	82	80	42	16	27	24	–	–	–	–	–	–

The number of full pupae found during searches over this period would appear to be the most reliable criterion of breeding.

The correlation between the number of full pupae deposited and the rainfall may be seen from Table I col. (a) & (g). During the dry months of June to October and again in February pupae were most abundant. The advent of rains in March and April and in November, December and January caused a marked decrease in pupae deposited in this site. The heavy rains early in 1951, which caused flooding in this area, made the site entirely unattractive to ♀♀ flies.

The only apparant lack of correlation in this generalisation was in January 1950 and in June 1950. The months of November and December 1949 were however wet months 2.59" and 2.05" of rain falling respectively. While 27 full pupae were found in November only 1 was found in December and the low numbers found in January 1950 were probably due to this depressant effect. The fall in the number of pupae in July 1950 may have been due to the low ground temperature of 21.9° C though this requires further investigation.

The correlation between the number of full pupae and the number of flies caught each month during regular weekly patrols in the area of the breeding site may be seen from Table I column (a) & (h). A decrease in the number of fly caught around the Kikuuni site is approximately reflected in a corresponding decrease in the number of full pupae. The only marked exceptions were in March 1950 when numerous fly were caught at Kikuuni but little breeding took place in the wet breeding site and again in May when the increased number of pupae found did not correspond to an increased number of fly. The reverse occured in September when the number of pupae found did not keep pace with the largely increased numbers of flies which were caught.

The correlation in the first 6 months of 1951 was however very close indeed, the number of flies caught reaching an all time low record and no full pupae were found during April and May.

The effect brought about by the flooding of the riverine sites was in many respects comparable to what might be expected from the clearing of riverine bush in this same area. Clearing of these riverine sites would cause a reduction in the fly population, especially in the dry season but a residual population would remain dependent on more upland breeding sites.

On the basis of these results it might be presumed that during the dry seasons when the Acacia-Commiphora bush is leafless and the soil is hard, dry, and hot, the shady, moist riverine site is most attractive to the ♀♀ flies. When the monthly rainfall however exceeds one inch, and trees in the open woodland regain their leaves, the riverine site loses its marked attraction. This tendency to breed away from the riverine sites occurs twice per annum corresponding to the long and short rainy seasons, and is a combined light-temperature-moisture response, the moisture response being predominant.

Direct evidence of the increased use of drier non-reverine sites during the rains is very difficult to find. Pupae in these areas are deposited in such a random fashion and in such small numbers over a wide area that regular counts have up-to-date been impossible.

(e) *Consequences of the problem.* The chief consequences which arise from this problem are: –

(i) the impossibility of formulating plans for reclamation of any area on the results of pupae searches, and

(ii) the difficulties in most cases of locating the source of dispersing flies.

In South Africa (DU TOIT and KLUGE, 1948), very considerable reliance is placed on pupae searches in deciding what areas should be sprayed with insecticide. Similarly, we in East Africa should at least like to find the primary breeding foci and so restrict the areas that must be cleared of bush in order to free any locality of *G.pallidipes*.

In the Makueni area it is evident that there is a seasonal shift of breeding sites, inwards towards the shady riverine vegetation in the dry season, and outwards towards the drier bushland during the rains. This shift is however not sufficiently pronounced to make it evident that *G.pallidipes* is entirely dependent on any one vegetation association at any one time of the year. When the riverine vegetation for 200 yards on each bank of the Keite River was cleared in 1948–50 fly still remained prevalent around Woti and to the west towards Unoa hill and the Nthangu Malibani barrier. Final eradication was only possible in this locality when the land within several miles of the river was cleared and occupied by human settlement. For this reason, therefore human settlement and tsetse eradication in Kenya must go hand in hand.

The difficulty of locating the origin of dispersing flies is all the more serious since so few *Glossina pallidipes*, when marked and released, are ever recovered.

Thus during the months of July to October 1949 there was an enormous increase in the fly catches in the cleared and settled eastern fringe of the fly belt around Unoa hill.

It was a physiological impossibility for flies to increase to the magnitude shown by breeding alone as in many cases the increase in numbers was five-fold within a few weeks. Nor is it likely that flies resident in each area would suddenly lose their shyness and come to the patrol screens with increased readiness in response to unknown stimuli. There appeared therefore to be genuine invasion of the cleared areas by *G.pallidipes* from uncleared areas further to the east. Having arrived in the cleared blocks upstream and found their vegetational habitat changed and unfavourable and possibly their food supply abnormal the flies became attracted with unusual readiness to fly patrol screens. It is however impossible to speculate on the exact origin of these flies in the absence of any knowledge as to whether increased breeding occurred immediately prior to this invasion and in what locality such breeding did occur.

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DISCUSSION

Mr. **Bertram** asks whether the invasion of *Gl.pallidipes* was due to immigration of game.

Mr. **Wilson** replies that there was no evidence supporting that assumption.

Mr. **Swellengrebel** asks if there was association with Tryp.rhodesiense.

Mr. **Wilson** says such an association has been noticed but that of T.rhodesiense with *G.morsitans* is more common.

Mr. **Gordon** asks if the decline in the incidence of pupae coincided with drop of the infection rate of the flies.

Mr. **Wilson** regrets that determination of infection rates could not be included in this survey. It will be later on.

ÜBER GROSSZUCHTEN VON TRIATOMIDEN SOWIE ÜBER DIE HAUTREAKTIONEN DURCH STICHE DER TRIATOMIDEN UND ANDERER BLUTSAUGENDER INSEKTEN

von
Albrecht HASE
Berlin-Dahlem, Deutschland

Von den fast ausschliesslich in Süd- u. Mittelamerika heimischen Triatomidae sind folgende Arten seit 1930 in Grosszuchten gehalten worden:
1) *Triatoma dimidiata* Latreille 1811; San Salvador
2) *Tr. infestans* Klug 1834; Tucumán/Argentinien
3) *Tr. rubrofasciata* de Geer 1713; Azoren
4) *Eutriatoma flavida* Neiva 1911; Cuba
5) *Eu. maculata* Erichson 1848; Venezuela
6) *Eu. rubrovaria* Blanchard 1843; Brasilien
7) *Panstrongylus megistus* Burm. 1835; Venezuela
8) *Rhodnius pictipes* Ståł 1872; Venezuela
9) *Rh. prolixus* Stål 1859; Venezuela.
Die jeweiligen Herkünfte sind angegeben.

Infolge von Kriegseinwirkungen sind die Zuchten der unter 1, 3, 4, 5, 6, 7, 8 genannten Arten vernichtet worden und erst 1949 konnten neue Zuchten eingerichtet werden. Zur Zeit werden im Laboratorium *Tr. infestans* und *Rh. prolixus* (beide aus Tucumán-Argentinien) gehalten. Unter Grosszuchten (Massenzuchten) werden Bestände von mehreren Tausend Individuen der in Betracht kommenden Arten verstanden. Es sind beispielsweise zur Zeit vorhanden von *Tr. infestans*, Imagines = 335; Lv. IV u. V. = 1325; Lv. I-III = 5928; zusammen = 6588 Individuen! - Der Bestand an *Rh. prolixus* beträgt rund 5000 Individuen. Seit 1950 wurden an wissenschaftliche Institute versandt: *Triatoma* Imag. rd. 1700; Lv. rd. 5000 Stück; von *Rhodnius* Imag., rd. 1800 u. Lv. rd. 3200 Stück. Bemerkenswert ist, dass auch *Tr. flavida* in beliebigen Mengen vor dem Kriege gehalten wurden; die Art galt bisher als nicht züchtbar. Die Haltung der Versuchstiere geschieht bei 27°- 28° C u. 60 - 70 % rel.F. in Glasschalen mit reichlich Filtrierpapier, um die feuchten Kotmassen aufzusaugen. Als Blutspender sind verfügbar: drei weibliche Personen u. 6 - 8 Meerschweine. Die Fütterung geschieht in den bekannten Kästen mit Gazeverschluss. Es wird abwechselnd Menschen- u. Meerschweinblut zur Aufnahme geboten. Diesem Umstande ist es wohl besonders zuzuschreiben, dass die Zuchten gut gedeihen.

Die Triatomidae sind für physiologische Versuche hervorragend geeignet; es sei nur an die grundlegenden Arbeiten von WIGGLESWORTH 1936; 1940; 1948; 1951 erinnert und auf seine Mitteilungen während dieses Kongresses. In dem von mir geleiteten Labor wurden vielerlei Versuche über die Wirkung der Stiche der verschiedenen Arten ausgeführt. Einzelheiten würden hier zu

weit führen. Im allgemeinen hat sich ergeben, dass die Stichempfindlichkei der verschiedenen Versuchspersonen unterschiedlich ist. Bei einem Teil der Versuchspersonen steigert sich die Wirkung bei Wiederholung der Stiche; bei anderen vermindert sich die Wirkung. Gegen *Rhodnius*-Stiche war di Empfindlichkeit am stärksten und ziemlich gleichbleibend.

Abb. 1. *Triatoma infestans.* Maskierte Imagines links und Larven rechts.

Im gange der Beobachtungen u. Versuche hat sich noch folgendes ergeben. Die Triatoma-Arten maskieren, tarnen sich, besonders die flugunfähiger Larvenstadien, mit staubförmigen Substanzen aller Art. Für *Tr. dimidiata*, *Tr. flavida*, *Tr. rubrofasciata* u. *Rh. prolixus* wurde dies schon früher festgestellt. Diesbezügliche neue Versuche mit *Tr. infestans* brachten das gleiche Ergebnis. Die Abbildung zeigt mit weissem Staub (Mehl) völlig und teilweise maskierte Larven und Imagines der letztgenannten Art. In diesen Zusammenhange interessiert die Tatsache, dass auch andere parasitäre blutsaugende Wanzen und zwar aus der Familie der Cimicidae (*Cim. lectularius*, *C. rotundatus*, *C. pipistrelli*, *Oeciacus hirundinis*) sich gegebenen Falles völlig maskieren (tarnen), so dass sie auf dem jeweiligen Untergrunde kaum erkennbar sind. Bei Cimiciden werden die Eier ebenfalls maskiert bei Triatomiden ist dies nie der Fall. (HASE, Z.f.Paraskde. 11: 419-429 1940; HASE, ebenda, 12: 388-403, 1942).

DISCUSSION

Mr. **Galliard** says that some Triatomidae can be easily reared, like *T. infestans*. *T. rubrofasciata* and *Rhodnius prolixus*; whereas *T. rubrovaria* offers great difficulties. Mr. **Hase** agrees with this statement.

SECTION XIII

INSECTICIDES AND TECHNIQUE OF CONTROL

EXPERIMENTS ON THE ABSORPTION AND FATE OF A SYSTEMIC INSECTICIDE BIS (bis dimethylamino phosphonous) ANHYDRIDE $[(CH_3)_2N]_2$ PO-O-PO $[(CH_3)_2N]_2$ IN PLANTS

by

S. H. BENNETT & W. D. E. THOMAS
Bristol, England

The study of systemic insecticides has progressed very rapidly in the last few years. This sudden impetus can be attributed largely to the work on the phosphorus compounds by SCHRADER, KÜKENTHAL and their colleagues in Germany. The idea of systemic insecticides is not a new concept, as for centuries man has been in search of substances with such properties. With the exception of salts of selenium, however, the use of which followed observations made by HURD-KARRER and POOS (1936), there was little success until Schrader's work (1947). Phosphorus containing systemic insecticides are now used on a large scale for the control of certain crop pests and there is an intensive search for new compounds with a wider range of insecticidal activity and a lower mammalian toxicity.

The compound on which probably most work has been done is the bis (bis dimethylamino phosphonous) anhydride. Our aims have been to investigate some of the factors associated with the absorption, translocation and ultimate breakdown of this material within the plant, and the use of the P^{32} labelled material has been the weapon which has helped us so considerably in this work.

It is proposed to give only a very brief outline of the techniques employed as full descriptions will be published elsewhere at a later date.

All plants used were raised in pots in a glasshouse, and after treatment were kept in a cold glasshouse for summer experiments, and in a heated one for winter experiments. The concentration of the aqueous solutions of the phosphonous anhydride applied to the various plants has varied between 0.6% to 0.025% and usually between 1 and 2 mls. have been applied to each plant with an activity of always less than 2.5 µ.c. per ml. The solutions were applied to the leaves either by dipping individual leaves into the solution or by spraying, using an artists spray pencil. Dipping has the advantage of giving a more uniform cover per unit area, but is a slow process, as each leaf must be carefully drained, and the method is unsuitable if a large number of plants have to be treated. After practice with the spray pencil, it is not difficult to attain an even distribution of the material on the leaf surfaces. The time of harvest after applying the solutions has varied between a few hours and several weeks, and the procedure adopted at harvesting has varied somewhat on the information desired.

Usually the treated leaves were leached in a series of solutions contained in staining jars. The composition of the leaching solution was 0.01% phosphonous anhydride with wetting agents added for some experiments. Each

leaf was dipped and kept agitated for 30 seconds in each of 3 jars of solution. Finally, all leaching solutions were transferred to a graduated flask and made to volume for radio assay. It was found that such a leaching procedure removed all the unabsorbed phosphonous anhydride from the leaf surface, as further prolonged leaching failed to remove any more. It has been assumed therefore that the phosphonous anhydride present in treated leaves after leaching has actually been absorbed.

In order to determine the amount of breakdown, extracts of the plant tissue were made and partitioned with chloroform, following the procedure suggested by RIPPER et al. Any samples for extraction which could not be handled immediately after harvest, were cut up and frozen in a mixture of acetone and solid CO_2 for 1 hour and then transferred to a deep freeze refrigerator at -20° C. until extraction was possible. This was to prevent any further enzyme activity occurring after harvest. In order to obtain a complete picture of the distribution of the material within the plant, any portion which for some reason or another it was impracticable to extract and partition, was digested in Kjeldahl flasks with nitric acid and made to volume for radio assay.

Absorption by leaves

It was found from an experiment made on apple stocks using two concentrations of phosphonous anhydride 0.5 % and 0.05 %, that there was a significant difference in the percentage absorbed from the two concentrations. It was also found that there was a significant difference in the percentage absorbed by plants treated with the same concentration at different times of the day. More was absorbed by plants treated in the morning than by those treated in the evening. This result is the same as FOGG found with D.N.C. where approximately 9 times as much was required to kill at the end of the day as in the morning. On the other hand it is the reverse of what has been found with the absorption of 2,4-D by DAVIS and SMITH (1950). Working with Red Kidney bean seedlings they found that 2,4-D was ineffective if the carbohydrate level of the plant was very low.

There appeared to be two obvious possibilities to account for the difference in absorption rates between morning and evening applications.

a) The carbohydrate content of the leaf at the time of treatment could be the important factor.

b) The physiological processes following application could be important. A period of photosynthesis would follow the application in the morning and a period of respiration would follow the application in the evening.

In order to test these possibilities a number of plants of Broad Bean, Runner Bean and Variegated Coleus were divided into two batches. One batch was subjected to light and the other batch placed in the dark before treatment. After treating the leaves with 0.5 % phosphonous anhydride each batch was further sub-divided. Some of the plants that had been in the dark before treatment were returned to the dark and others subjected to light, while of the plants that had been in the light before treatment, some were returned to the light and others placed in darkness. It was found from this experi-

ment that the different species of plant varied considerably in the amount of phosphonous anhydride absorbed under comparable conditions. There was also wide differences in the behaviour of the different species under the range of light conditions used. It also showed that the most important factor in absorption was that light, which we think can be interpretated as photosynthesis, should follow the application of the material.

One further point about absorption was whether there was any difference in the absorption by upper and lower leaf surfaces. We have not, as yet, investigated this matter very thoroughly. Leaves of comparable age on a number of chrysanthemum plants were selected and a known volume of 0.4% radio active phosphonous anhydride was applied in some cases to the upper surface, in others to the lower surface and in others to both surfaces. Approximately the same surface area was treated in each case and the results obtained from this experiment suggest that the lower leaf surface is more absorptive than the upper leaf surface.

Translocation

The amount of phosphonous anhydride translocated from the treated leaves to other parts of the plant can be measured by removing the treated leaves from the plant after a certain time interval and harvesting the rest of the plant separately. If information is required on the particular whereabouts in the plant of the translocated material, then the plant may be divided into a number of sections. It was found by treating leaves in various positions on the stem of apple stocks that 8 hours after treatment less than 0.5% had been translocated from the treated leaves to other parts. 72 hours after treatment about 5.0% had been translocated, and after 144 hours about 10.0% except where leaves near the top of the plant had been treated when the amount translocated was less than 5.0%. In all cases the direction of translocation was to the leaves above rather than to leaves below those treated. Quite a high proportion of the translocated material was found in the lower part of the stem and roots.

It was found from an experiment on chrysanthemums that the amount of absorbed material translocated from the treated leaves was quite small being only 8.0% after 384 hours.

It was found from a number of experiments that translocation like absorption was affected by external conditions. If leaves were sprayed with a solution of phosphonous anhydride when their carbohydrate content was low, and the plants placed in the dark after spraying, then little translocation from the treated leaves took place. If, however, the leaves had a fairly high carbohydrate content at the time of treatment, and the plants were placed in the dark after spraying then limited translocation took place. Greatest translocation in all cases occurred where plant processes were active and it is possible therefore that the translocation of the phosphonous anhydride is closely associated with carbohydrate movement.

Breakdown

It is well known that plants that have been treated with phosphonous an-

hydride, fortunately lose their insecticidal properties after a period of time. The two obvious possibilities that would account for this are either

a) the phosphonous anhydride is broken down within the plant into substances which are no longer insecticidal

b) the extension growth of the plant dilutes the concentration of the insecticide in the sap stream to a sublethal concentration.

From the results of our experiments there would appear to be some evidence of truth in both these statements. By partitioning the plant extracts with chloroform, using the technique referred to earlier in the paper the amount of breakdown was determined. It was found that this varied considerably in the various plant species used and a few results are given in the following table.

Breakdown of phosphonous anhydride in various plants 7 days after treatment

Plant Species	Aq. phase	$CHCl_3$ phase
Runner Bean	49.8	50.2
Broad Bean	48.0	52.0
Apple	31.9	68.1
Chrysanthemum	13.1	86.7
Coleus	9.8	90.2

From this table we can see that under the same conditions, different plants vary in the rate at which they break down phosphonous anhydride. It is fair to make the assumption from such figures that in a plant like Broad or Runner Bean, breakdown could account for loss of insecticidal activity, whereas in Coleus and Chrysanthemum dilution in the sap stream by new growth to a sub-lethal concentration may be an important factor. In apple stocks no difference in the breakdown ratio was found between the different parts of the plants so that there would appear to be no particular site for breakdown.

By treating plants as already described and infesting them with aphides, it will be seen that the method can be successfully used to determine the concentration necessary within the plant to kill a certain species. All our results are not yet completed, but with the bean aphis (*Aphis fabae* Scop.), the concentration is about 10 mg/kg. The feeding habits of some species that show a preference for a particular limited portion of the plant, may tend to make figures obtained rather approximate, as the distribution of the material within the sampled section may quite well vary.

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DISCUSSION

Mr. **Ketelaar**: Do you have information on the nature of the breakdown products?

Mr. **Bennett**: No.

Mr. **Ketelaar**: Do you know if your substance in the $CHCl_3$ layer is the unchanged active ingredient?

Mr. **Bennett**: The material in the $CHCl_3$ layer has the same partition coefficient as the original material.

Mr. **Hopf**: Was the author's only criterium of breakdown the solubility in $CHCl_3$? Did he try to make any substitution within the H_2O and $CHCl_3$ fractions?

Mr. **Bennett**: Solubility in $CHCl_3$ was not the only criterion. The partition coefficient of the $CHCl_3$ layer was checked, and found to be the same as that of original material.

Mr. **Newman**: Were precautions taken to ensure that the conditions of temperature and humidity in the neighbourhood of the leaves were identical in plants investigated in dark and light? Is transpiration rate probably of more importance than photosynthesis in carbohydrate content?

Mr. **Bennett**: Measurements were made of temperature and humidity in the boxes in which the plants were kept, although not at the actual leaf surfaces.

Mr. **Jary**: If no rain falls, is it important whether the plant is treated in the light or the dark? As an additional point, is the absorption complete in a few hours or may it continue for say 48 hours over similar light-dark periods.

Mr. **Bennett**: In the absence of rain, absorption continues. In, say, about 24 hours, approximately 50% of the deposit may be absorbed and absorption will continue at a decreasing rate, so that in practice, in the absence of rain, it is not important whether plants are sprayed in light or dark.

Mr. **Walrave**: How can we understand that transport is so little from the treated part of the plant in the direction of the roots? The substance has to come into the phloem before the aphids can take it. There is often a transport in the phloem to the roots.

Mr. **Bennett**: There is often a relatively high amount in the roots and lower part of the stem but not in the leaves below the treated ones. Transport of the materials within the plant is complicated and little understood.

Mr. **Ketelaar**: From the figures of Mr. Bennett it seems to follow that downward translocation is practically absent whereas the upward translocation is a very small fraction of the insecticide applied (and absorbed). Does this apply to all plants?

Mr. **Bennett**: Transport to leaves below the treated leaves has been found to be very slight in all plants tested.

Mr. **Ketelaar**: If this is the case has then application of these substances any practical value?

Mr. **Jary**: In the application of this substance to hops for the control of *Phorodon humuli*, there is no evidence that translocation takes place downward. There is considerable translocation upward, but in practice it is unwise to expect this to take place more than about 1 foot. The phenomenon may be different in wooden plants, e.g. apple; the answer in this instance refers only to hop, an herbaceous perennial.

SEED DRESSINGS WITH BHC AND LINDANE

by
J. MELTZER
's-Graveland, Netherlands

Introduction.

The usual soil treatments with BHC for the control of soil insects is relatively laborious and expensive. Besides the soil remains unfit for a considerable time for several crops of which subterranian organs should be consumed by man.

Much research has already been done in order to find a more easy, less expensive method and last not least one which has not the disadvantage of tainting subterranean crops. In literature several authors have been dealing with combined drilling and seed dressing, but the possibilities of the latter and the safe limits of dosage are even now not yet exactly known.

HENSILL (Agric.Chem. IV, 9 (1949) pp. 29-30) recommended a.o. the following dosages of BHC for seed dressing:

Sugar beets	2,5 gram γ-isomer per kg seed
Corn, Peas, Oats	0,625 gram γ-isomer per kg seed
Beans	0,3125-0,625 gram γ-isomer per kg seed
Large beans, Wheat	0,1625-0,3125 gram γ-isomer per kg seed.

In our field experiments we concluded that with sugar beets 2- 2,5 gram γ-isomer per kg of seed was necessary to prevent damage by wireworms in cases of heavy attack. Though we have not yet obtained conclusive results we think the dosage of 0,1625-0,625 gram of γ-isomer per gram of grain seed too low for this country. The next experiments will give some idea of the safe limits for the use of BHC and lindane in seed dressing.

Germination tests.

a. Grain seeds.

The germination tests were carried out in petridishes with moistened filter paper, and these were kept for 3 days in an incubator. The temperature was changed every 12 hours from 24° C to 30° C and reversely. After 3 days the roots were measured. The results taken together in table 1 express the percentages of growth inhibition with respect to the root length of the not treated seeds. Though the germination is not affected at all, the growth inhibition by all seed treatments (except one with 0,15 gram lindane) is obvious.

Table 1
Growth inhibition of grain roots grown in closed petridishes after dressing with BHC and lindane.

Test no		51312	51318	51323
g γ/kg seed		Wheat	Rye	Barley
BHC	0,15	63 %	-	-
	0,30	75 %	75 %	-
	0,60	77 %	80 %	51 %
	0,90	-	-	60 %
	1,20	-	85 %	60 %
Lin-dane	0,15	16 %	-	-
	0,30	20 %	29 %	-
	0,60	37 %	47 %	29 %
	0,90	-	-	28 %
	0,20	-	71 %	51 %

According to these tests wheat and rye are much more sensitive for BHC than barley. It is remarkable however that rye seed seems to be more sensitive for lindane than wheat whereas the sensitiveness of both for technical BHC is the same. It might be that technical BHC contains at least one substance other than γ, against which these species react in a different manner.

b. Corn.

Seeds treated with BHC at the dosage of 0,3 g γ/kg showed a growth inhibition of 55 %, whereas those treated with lindane showed a reduction of root length of 42-57% (table 2).

Table 2
Germination of corn in closed petridishes. Test no 51328

Treatments	g γ/kg	Median root length in mm
1. No treatment		41,8 $\pm$ 3,4
2. Lindane	0,3	27,4 $\pm$ 1,7
3. Lindane	0,6	19,0 $\pm$ 1,7
4. Lindane	1,2	21,3 $\pm$ 1,2
5. Lindane	2,4	18,1 $\pm$ 1,2
6. BHC	0,3	19,0 $\pm$ 0,3

c. Sugar beet.

As can be seen from table 3 sugar beet is far less sensitive than grain and corn.

Table 3

Germination of sugar beet in closed petridishes. Test no 51306

Treatments	gγ/kg	Median root length in mm
1. No treatment		11,4 ± 1,1 mm
2. Carrier in excess		13,4 ± 1,2 mm
3. BHC	2,5	6,0 ± 0,3 mm
4. BHC	5,0	5,75 ± 0,2 mm
5. Lindane	2,5	10,1 ± 0,8 mm
6. Lindane	5,0	6,2 ± 0,4 mm

Glasshouse trials.

In the glasshouse trials the plants were sown in pots, each pot containing 50 seeds. Some days after sowing, germination rate and length were observed. In general the length was measured by using classes i.c. 0-½ cm, ½-1 cm, 1-2 cm, and so on. In this way the length was expressed in units according to the classes used.

a. Wheat.

Table 4 shows the germination rates and the units obtained by the various treatments. Unfortunately the seeds not treated with mercurial seed dressing showed a heavy attack of seedling diseases. Of the desinfected seeds those treated with BHC showed a highly significantly lower germination rate and unit total.

Table 4

Glasshouse trial with wheat.

Germination rate and unit total 6 days after sowing. Test no 51316.

Treatment			Results	
x Mercurial dressing - No merc.	BHC g γ/kg	lindane g γ/kg	Germination (150 seeds)	total units
1. x	-	-	144	168
2. -	-	1,2	132	130
3. -	1,2	-	94	74
4. x	-	0,3	140	172
5. x	-	0,6	144	184
6. x	-	1,2	136	138
7. x	1,2	-	100	68

b. Rye.

All seeds were desinfected with a mercurial dressing. The treatment with BHC only showed a significantly less unit total (table 5); the germination rate, however, was not affected.

Table 5

Glasshouse trial with rye. Test no 51340

Treatment	g γ/kg	Unit amount	
		Total	Median unit per seedling
1. Control		1.924	7,7
2. BHC	0,3	*1.490*	*6,0*
3. Lindane	0,6	1.920	7,7
4. Lindane	0,9	1.888	7,6
5. Lindane	1,2	1.852	7,4

c. Barley.

All seeds were desinfected with a mercurial dressing. The difference between BHC at a dose of 0,6 g γ/kg and the control was not significant, but the higher doses of BHC were (table 6):

Table 6

Glasshouse trial with barley. Test no 51339

Treatment	g γ/kg	Amount of unit	
		Total	Median per seedling
1. Control		1.355	6,8
2. BHC	0,6	1.253	6,3
3. BHC	1,2	*1.138*	*5,7*
4. BHC	2,4	*1.063*	*5,3*
5. Lindane	0,6	1.344	6,7
6. Lindane	1,2	1.336	6,7
7. Lindane	2,4	1.313	6,6

d. Oats.

All seeds were desinfected with a mercurial dressing. All treatments with BHC resulted in significantly resp. highly significantly lower unit amounts than those with lindane or the control (table 7):

Table 7

Glasshouse trial with oats. Test no 51344.

Treatment	g γ/kg	Control after 5 days Unit amount		Control after 9 days Unit amount	
		Total	Median p.seedl.	Total	Median p.seedl.
1. BHC	0,6	1.041	5,2	*1.831*	9,2
2. Lindane	0,6	1.290	6,5	2.499	12,5
3. BHC	0,9	*965*	*4,8*	*1.645*	*8,2*
4. Lindane	0,9	1.169	5,8	2.293	11,5
5. BHC	1,2	*808*	*4,0*	*1.306*	*6,5*
6. Lindane	1,2	1.029	5,1	2.179	10,9
7. Control		1.139	5,7	2.584	12,9

c. Corn.

Corn treated with lindane at doses of 0,3-2,4 g γ/kg and BHC at a dose of 0,3 g γ/kg did not show any influence on germination or growth.

d. Sugar beet.

With sugar beets only an excessive dose of BHC (5 g γ/kg) resulted in reduction of the height of the seedlings (table 8).

Table 8

Glasshouse trial with sugar beet. Test no 51309

Treatment	g γ/kg	Amount of units		
		after 7 days	11 days	14 days
1. BHC	1,25	116!	315	601
2. Lindane	1,25	55	274	574
3. BHC	2,5	83!	245	553
4. Lindane	2,5	65!	256	544
5. BHC	5,0	*17*	*170*	*461*
6. Lindane	5,0	121!	327	653
7. No treatment		55	232	577

It is to be noted that the normal doses of BHC and lindane have a stimulating effect on the germination. Within one week the differences disappear however.

Effect of storage of seed treated with BHC and lindane.

Germination rate and growth of treated seeds were examined after 1-4 months of storage. Of all seeds under examination those treated with BHC were damaged after one month of storage in closed glass vials which were kept at room temperature. The damage was expressed by reduced germination rate and growth.

Table 9

Effect of storage during 3 months on treated wheat seeds.
Test no 51342

Treatment x Mercury - No Merc.		BHC	Lindane	Germination rate	Median unit per plant
		g γ/kg			
1.	x	-	-	113	8,3
2.	-	-	1,2	113	8,5
3.	-	1,2	-	108	*5,6*
4.	x	-	0,3	109	7,9
5.	x	-	0,6	109	8,1
6.	x	-	1,2	111	7,9
7.	x	1,2	-	111	*4,0*

a. Wheat.

Table 9 shows that lindane has no influence on the seeds which were stored after treatment for 3 months (table 9). Even 1 month of storage resulted in a highly significant low germination rate and growth by BHC at doses of 0,3-0,6 g γ/kg.

b. Rye.

Also with rye it seems impossible to treat the seeds with technical BHC without damaging them. All treatments with lindane on the other hand, even after three months of storage, resulted in a normal germination and growth (table 10). Unfortunately the seedlings of test no 51346 suffered from a serious attack of seedling diseases (the seeds had not been disinfected), so that the figures cannot be relied on.

Table 10
Effect of storage on rye seed, treated with BHC and lindane.
Test no's 51335, 51346

Treatment	g γ/kg	Duration of storage		
		1 month		3 months
		Germ. rate	amount units	amount of units
1. Control		141	7,2	7,6
2. Carrier only		166	7,4	-
3. BHC	0,3	152	*5,9*	-
4. BHC	0,6	153	*4,0*	*3,8*
5. BHC	1,2	*129*	*4,3*	*4,4*
6. Lindane	0,3	153	7,5	-
7. Lindane	0,6	145	7,6	6,2
8. Lindane	1,2	141	7,6	6,7

c. Sugar beet

As can be seen from table 11 BHC at a dose of 5 g· γ/kg of seed gives a significantly poorer stand after one month storage. The difference between the control and the normal treatment with BHC, although not significant, is obvious.

When stored 4 months, however, both treatments with BHC result in highly significant differences with the control. Normal doses of lindane do not differ significantly with the control.

All seeds were treated with Duphar mercurial dressing. The results are summarized in table 11.

Table 11
Effect of storage on seeds of sugar beet, treated with BHC and lindane. Test nos 51319 and 51345

Treatment	g γ/kg	Duration of storage		
		1 month	4 months	
		units	units	germination
1. Control		690	728	178
2. BHC	2,5	607	484	157
3. BHC	5,0	519	439	147
4. Lindane	2,5	560	709	188
5. Lindane	5,0	668	663	181

Discussion.

From the above mentioned tests it is clear that the examined seeds cannot be treated with technical BHC with the exception of sugar beet. It may be that this does not hold true for corn too, but we think this not very probable, for the effective dose will surely exceed 0,3 g γ/kg.

With BHC sugar beets should be treated a short time before sowing in order to prevent damage. Thus in each case where treated seeds should be stored some time before sowing, lindane should be used.

The laboratory germination test is a very sensitive one for detecting possible-damaging factors of formulations. The rate of inhibition in the laboratory tests does not correspond with that in the field. With grain seed damage in the field only occurs when the laboratory test indicates reductions of at least 60 %.

HOCKING (Scient. Agric. 30, 5 (1950) pp. 183-193) who states that the damage of the seed is not due to the γ-isomer, suggests that volatile breakdown products as trichlorobenzenes may be responsible. Our preliminary trials in this direction do not confirm this theory. Damage to the seed is possible as soon as the formulation is not based on pure γ-isomer.

DISCUSSION

Mr. **Ketelaar**: What is the cause of the inhibition by crude BHC? Do equal amounts of total BHC and lindane give a different degree of inhibition?

Mr. **Meltzer**: The inhibition by BHC is not a specific one. HOCKING suggests the action of breakdown-products. Our preliminary experiments however show that the reduction of the growth could not possibly be caused by these products, as the concentration at which they act can not be produced in the time of the experiments.

Mr. **Stapley**: Gamma BHC is about 8 times as toxic as crude BHC, therefore it is more suitable as a seed dressing. BHC is too phytotoxic to seedlings but phytotoxicity must be judged on the final stand of plants; laboratory germination tests are often misleading. The cost to the user is much reduced compared with treatment of the soil with BHC for wireworm control, quite apart from BHC affecting the flavour of potatoes. The rate per acre of the insecticide is important and must be judged on row widths of the crop. Lower rates can be used where rows are close, as in cereals, but higher rates are required for sugar beet. Storage of treated seed may lead to a loss of insecticide and such seed, when sawn, may not control pests. This is also important now that it has been shown that gamma BHC seed dressings do not effect germination after 12 months.

Mr. **Gunthart** remarks: In Petrischalen geben schon ca. 10 mal kleinere Mengen Lindane Keimschäden als im Freiland; daher sind nur Freilandversuche in normaler Erde ausschlaggebend. Technisches Hexa kommt nicht im Frage, weil es stärker keimschädigend wirkt, die notige Dosis schlecht an Körnern haftet und bei Nachkulturen, z.B. Kartoffeln, Geschmacksveränderung auftreten kann. Von Dieldrin werden im Freiland die grössten Mengen ohne Keimschädigung ertragen.

CONTROL OF GRUBS OF THE DAFFODIL FLY IN BULBS BY CARBONIC ACID AND OXYGEN UNDER PRESSURE

by
W.E.de MOL VAN OUD LOOSDRECHT
Amsterdam, Netherlands

The grub of the daffodil fly (*Lampetia equestris* F.) is not killed by the strongest X-ray treatment permissible without damaging the new bud in the bulb. By a treatment with very short electro-magnetic waves (140 cm and 60 cm) the grub has been repeatedly killed without any damage to the bulb. This control may be due to molecular conversions the grub. To know exactly whether the treatment can be useful in practice, these experiments had to be performed on a larger scale.

Administration of nitrogen, carbonic acid and oxygen at atmospheric or higher pressures, even of 500 atmospheres (nitrogen) failed to kill the grub. By applying a particular combination of gases (carbonic acid and oxygen) the grub could be destroyed.

During these *first trials* with the carbonic acid-oxygen pressure method (1938) it appeared that optimum control of the grub of the daffodil fly was obtained in a 24-hour treatment with a mixture of 20% carbonic acid and 80% oxygen at a pressure of 12 atm, and that by a 48-hour treatment the grub dies under all circumstances. A patent has been granted in the Netherlands on this carbonic acid-oxygen-pressure process; it has also been patented in France, England and the U.S.A.

During the *second series* of experiments (1939) it appeared that in the second half of September the grubs could still be killed in a 10-hour treatment, the other conditions being the same as in 1938. Afterwards the duration had to be extended up to 24 hours, which is to be ascribed to the drop in temperature.

An extensive investigation was instituted regarding the development of sprouts after the treatment. When use is made of bulbs of good quality and the treatment takes place earlier than in October and November, the result with the forced ones as well as with those planted in the open field can be satisfactory.

The *third series* of experiments (1940) taught us that the treatment should not be started too early because the bulbs are not yet ripe enough then and not yet dry. Till the first half of October the grubs could be killed by a 15-hour treatment. Afterwards the grubs were killed after 24 hours with heating and always after 48 hours without heating. From the flowering of the treated bulbs (spring 1941) it could be concluded that the method can be satisfact-

ory, provided the bulbs are ripe and dry and are treated and planted in du time, i.e. in August and September.

A *fourth series* of trials was completed in 1941, many growers being in vited to see the results.

The first object was grub control, the following results being obtainec On emptying the pressure vessel after the treatment, not all the grub were dead, though they did not move any longer. The gases were pressed in to the bulbs, in which the grubs were visible. After 6 days all the grubs wer dead. Oxygen cannot be replaced by compressed air. A treatment of at leas 8 hours is required, 30% of carbonic acid with 70% of oxygen giving th best results.

Secondly, the experiments aimed at determining the flowering conditio in the spring of 1942 of the bulbs which had been treated in 1941 and forc ed afterwards. Together with several flower bulb growers who had followe these experiments, the following conclusions could then be drawn:

Control of the daffodil fly according to the carbonic acid-oxygen pressur procedure can be considered as pioneering. This method is of the greates interest for the commercial purposes of the daffodil cultures. It is simpl and economically justifiable and does not involve any danger, provided w do not proceed in a reckless manner. Between the time of digging up an planting we are not bound to a certain period; the bulbs can be exported i the same year in which they have been treated. The unfavourable influenc of treatment on the flowers is of very little importance. When the bulbs ar planted in time flower and leaves will grow according to expectations.

Thirdly, this fourth series of experiments was necessary to determine th behaviour of the bulbs regarding flowering and further growth when simpl planted in full ground in 1942. During the flowering in the field (spring 1942 the quality of the flowers, leaves and roots was accurately checked. Flowe ing started at the normal time, though the severe winter had some influenc in this respect. The flowers were normally shaped, the leaves showing n abnormalities; they kept their green colour for a long time; roots were als developed satisfactorily. Even in the longest treatment (19 hours) the growt was good. Owing to the severe winter the treated as well as the untreate plants sometimes showed some damage.

When carbonic acid and oxygen were used in another proportion than 20 80, viz. 30: 70, 50: 50 and 35: 65, no abnormalities could be detected. I two experiments (30% CO_2 and 70% O_2) the growth was even considere to be among the best of the 21 trials.

Incidentally it may be observed that nothing abnormal was found eithe when exclusively compressed air, a mixture of carbonic acid and compresse air, or a mixture of carbonic acid, oxygen and compressed air was administ ed. Even when carbonic acid and oxygen were applied in inversed sequence the growth was normal. The treated bulbs were often not outdistanced i

growth by a superannuated vegetation.

Not only by complete control of the grubs, but also by good cultivation of the bulbs after forced blooming and after flowering in the field did the growers show great interest in these experiments.

Continuous efforts have now been made to improve the method for practical purposes. Therefore the year 1942 with its unfavourable time (much rain during the digging and preservation of the bulbs, which promoted rotting) was extremely fertile. For the fifth time a trial with the carbonic acid-oxygen pressure method was done. First 44 tests were made in 4 series.

On account of the results of these 44 experiments, there is no doubt that, under the prevaling unfavourable weather conditions all varieties stand a pressure of 13 atm. in the second half of August or in the beginning of September, in which case 100% control of the grub is obtained provided the required carbonic acid-oxygen ratio is observed and the bulbs are wind-dry; meanwhile the pressure has been somewhat increased, the number of hours being decreased.

We did not stop after this fifth year of experiments (1942). A number of bulbs, which were subjected to a treatment resulting in the death of the grub, were brought to early blooming, as soon as it appeared that these bulbs could stand the wet, cool summer. The rest of these bulbs was not forced, but planted in full ground. Part of these bulbs was cooled before forcing them; the rest was not exposed to the cold. It has been stated that it is not sufficient to subject the bulbs to a carbonic acid-oxygen pressure and to cool them afterwards. Forcing the bulbs which were first cooled and then treated with carbonic acid and oxygen, however, proceeded normally. The bulbs, which were brought to early blooming after treatment without cooling, developed leaves and flowers which did not show the least damage. It appeared that bulbs, treated during a wet, cool summer in the last week of August or in the first week of September with 20-30% carbonic acid and 70-80% oxygen for 6-8 hours at 12-14 atm with or without cooling can yield normal, undamaged leaves and flowers when forced. 4-hour treatments were even performed in which at a pressure of 25 atm. the daffodil King Alfred came to an early bloom.

Many suggestions, theoretical as well as practical, were made during and after these experiments. However, they must be left out of consideration. From 1938 up to 1943 inclusive, experiments were made with a quantity of bulbs, not larger than 1 hl. In 1944 for the first time a large pressure vessel was used (length 6 m, diameter 1.10 m), and shortly afterwards a second (length 10 m, diameter 1.10 m). These vessels gave ample opportunities to treat the bulbs in large quantities. On the strength of the experimental work from 1944 up to now in particular, I am convinced that the carbonic acid-oxygen pressure method opens up favourable prospects.

My opinion is summarized in the following suggestions: an installation for co-operative treatment in each large daffodil centre, and/or similar in-

stallations in the ports of Rotterdam and Amsterdam. Equipment for the preparation of carbonic acid and oxygen in the immediate neighbourhood, the whole equipment being at the same time applicable for other purposes.

DISCUSSION

Mr. **Hartzell**: Have you used this treatment on lily bulbs or gladiolus corms?

Mr. **de Mol van Oud Loosdrecht**: No, only on daffodils.

Mr. **Ketelaar**: Has the speaker made experiments with fumigation at 1 atm with toxic gases like hydrocyanic acid and methylbromide? The high pressure vessels are certainly more costly than those normally used for fumigation.

Mr. **de Mol van Oud Loosdrecht**: With Calcid, the bulbs and sprouts were damaged.

Mr. **Chamberlain**: Can treated bulbs be stored for long periods prior to planting? For instance, could they be shipped to Australia with good prospect of their being planted there without adverse effects on growth? Recent import regulations introduced by Australian and Tasmanian authorities require certain forms of treatment, but we have as yet little experience of their practical application in view of the long period the bulbs are travelling to Australia.

Mr. **de Moll van Oud Loosdrecht**: We have sent the treated bulbs to Canada and not to Australia.

Mr. **Stapley**: Does gas treatment control eelworm? Eelworm is normally controlled by warm water treatment, which also controls daffodil flies. Routine treatment is essential for eelworm control. For this reason daffodil fly is not common in Holland. Damage to bulbs by daffodil fly is already in progress when gas treatment takes place. Correct control is to prevent attack.

Mr. **de Mol van Oud Loosdrecht** aks the opinion of Mr. KABOS as to whether the larvae will always be killed by the hot water treatment.

Mr. **Kabos**: The daffodil fly belongs to the group of univoltine Syrphids with only one generation a year. As my few experiments show the larvae can easily survive a temperature of 47^{o} C.

Mr. **Rahman**: Could you please tell me the percentage of mortality at different dephts of the bulb store?

Mr. **de Mol van Oud Loosdrecht**: As far as I know complete killing takes place at all levels in the bulb store.

VORBEUGUNG GEGEN TERMITENBEFALL

von

Otto HESPELER

Lübeck, Deutschland

Die Termiten sind die gefährlichsten Holzzerstörer in tropischen und sub-
pischen Ländern. Der Kampf gegen diesen Schädling ist international. Wis-
nschaft und Industrie verschiedenster Länder haben sich intensiv mit die-
r Frage beschäftigt, darunter auch deutsche Biologen und Chemiker. Ich
öchte hier nur einen kurzen Ausschnitt über deren Mitarbeit an diesem
ampfe geben.

Termiten sind glücklicherweise in Deutschland nicht heimisch, aber wir
aben doch das zweifelhafte Vergnügen, beweisen zu können, dass diese
opischen Tiere auch in gemässigtem Klima auftreten und ihr Fortkommen
nden können.

Im Jahre 1937 legte ein Arbeiter in einem Schacht am Sievekingplatz in
amburg seine Jacke über ein Abstützbrett. Dieses brach unter der Belastung
usammen und hunderte von Termiten krochen heraus. Man untersuchte dar-
ufhin die Umgebung und fand ganze Termitenkolonien. Unter der Leitung von
errn Dr. WEIDNER vom Zoologischen Staatsinstitut wurde gründlich ver-
ucht, diese zu vernichten, und es wurden sogar erhebliche Abbrucharbeiten
orgenommen. Larven in Erde und Mauerschutt konnten durch DDT-Staub ge-
tet werden, Holz, dass vorbeugend mit Xylamon behandelt war, ist nach
r Feststellung Dr. WEIDNERs nicht von Termiten angegriffen worden.

Aber dass diese Tiere jahrelang im Verborgenen weiterwirken, sah man
Jahre 1951, als man Bombenschäden beseitigte und im Hause Pilatuspool
r. 14 einen vollständigen Termitenschaden in der Erdgeschosswohnung
ststellte. Alle Holzteile, ja sogar die schweren Balken, die man im Kriege
egen Bombensplitter dort angebracht hatte, waren völlig im Innern zerstört
d brachen bei der Berührung zusammen.

Im Hause Holstenwall Nr. 8 fand man sogar die wundervoll angelegten Ver-
ndungsgänge eines im Aufbau begriffenen Termitenstaates. In beiden Fäl-
n handelt es sich um nordamerikanische Feuchtholztermiten, (***Reticuliter-
es flavipes*** Koll), die ihren Vernichtungsweg immer von der Erde aus an-
eten und von dort aus ihre Gänge an das zu zerstörende Holz heranbauen.
e waren sicher mit Schiffen von Übersee eingeschleppt worden, und es ist
staunlich, dass sie, ohne Schaden zu nehmen, den Hamburger Winter mit Ne-
l und Regen überstanden haben und hier genau so ihre Staaten gründeten
e in ihrer heissen Heimat. Die 1937 geäusserte Annahme, dass Termiten in
rdeuropa nur in Häusern mit Zentralheizung leben könnten, traf also nicht
, denn man fand sie selbst lebend in Bauteilen, die jahrelang überhaupt
cht geheizt wurden.

Da jeder Termitenstaat nur zwei aktive Geschlechtstiere, den König und die Königin, hat, und nicht gerade anzunehmen ist, dass mehrere solcher Paare aus Übersee kamen, muss man annehmen, dass aus den „Arbeitern" und „Soldaten" durch eine besondere Fütterung von Junglarven mit Nährsäften geflügelte Geschlechtstiere gezüchtet wurden, die nach einem Hochzeitsflug eine geeignete Stelle fanden, um einen neuen Staat zu gründen. Es besteht durchaus die Gefahr, ja es ist sicher anzunehmen, dass weitere solcher Kolonien bestehen, die man dann erst merken wird, wenn ihr Zerstörungswerk weit, vielleicht bis zur Einsturzgefahr des Hauses, gediehen ist. Hamburg steht mit Termitenbefall im übrigen nicht allein in Europa, im historischen Wiener Schloss Schönbrunn wurden sie unter anderem ebenfals gefunden.

Mit Termiten hat man sich in Deutschland aber auch auf einem anderen Gebiete beschäftigt. Wenn auch die Hamburger Termitenkolonien hoffentlich Einzelerscheinungen bleiben, so haben wir doch hier einen ähnlich arbeitenden, sehr häufig auftretenden Holzzerstörer, den Hausbock (*Hylotrupes bajulus L.*), dessen Bekämpfung eine volkswirtschaftlich hochwichtige Angelegenheit geworden ist. Man hat nun festgestellt, dass die Termiten, besonders die in Mittelmeerländern geheimateten Trockenholztermiten (*Kalotermes flavicollis F.*) besser als jeder andere Holzschädling als Standardversuchstier zur schnellen und sicheren Prüfung von Holzschutzmitteln geeignet ist.

Darüber hinaus sind aber, wie Dr. GÖSSWALD berichtet, die Termiten besonders auch geeignet, den Wert von Tropenwerkstoffen und vielen anderen Werkstoffen zu prüfen, die grossen Klima- und Feuchtigkeitsunterschieden (z.B. in Flugzeugen) ausgesetzt sind. Es wurden daher in einem deutschen Institut künstliche Kolonien von Termiten für solche Versuchszwecke gebildet. In diesem Zusammenhang möchte ich noch die Untersuchungen von Herrn Dr. BECKER erwähnen, der sich besonders mit den Einflüssen des Klimas auf die Bekämpfungsmittel beschäftigt hat.

Aber schon lange vor den eben geschilderten Vorgängen beschäftigten sich deutsche Firmen praktisch mit der Termitenbekämpfung, sowohl in den ehemaligen deutschen Kolonien wie auch in weiten Teilen anderer tropischen Länder. Wieder waren hier die Erfahrungen bei der Bekämpfung deutscher Holzschädlinge, und zwar des Hausschwamms (*Merulius lacrymans* Schm.), des Hausbocks, der Anobien und zahlreicher sonstiger Schädlinge eine ausgezeichnete Grundlage für den Kampf gegen den entfernt verwandten tropischen Holzzerstörer. Daher konnten deutsche Firmen Erzeugnisse in den Handel bringen, die sich als erfolgreich im Kampf gegen Termitenzerstörungen erwiesen.

Aber auch die Erfahrung, die mit diesen Mitteln gemacht wurden, zeigte dass es fast unmöglich ist, durch Giftstoffe (Abwehrmittel), die in weitverzweigten Gangsystemen lebenden Termiten zu vernichten und sie aus bereits angefressenem Holz zu vertreiben. Ihre Stosskraft ist so gross, und ihre

Arbeit geht dann, wenn sie ein Holz in Angriff genommen haben, so schnell, dass eine Bekämpfungsaktion meist zu spät kommt.

Soweit deutsche Ingenieurs und Unternehmungen in tropischen Ländern bauten, halten auch sie so weit als möglich eine termitenfeste Ausführung, also in Beton, für das Richtigste. Aber dies lässt sich nicht überall durchführen, und in zahllosen Fällen muss man doch zum Holz als Baustoff greifen. Abgesehen davon, dass man solche Häuser wenigstens auf Betonpfeiler stellen oder wenigstens mit Termitenblechen versehen sollte, ist der vorbeugende Schutz des Holzes unbedingt zu empfehlen, das heisst, ein Anstrich oder eine Tränkung des zu verwendenden Holzes mit einem Giftstoff, der dieses für Termiten unangreifbar macht. Dabei ist es natürlich notwendig, dass dieser Termitenabweisende Stoff Menschen und Haustieren nicht schädlich wird.

Schon vor vielen Jahren wurden deutsche Destillate aus Steinkohlenteeröl, zum Beispiel Avenarius - Cabolineum, für diesen Zweck verwendet. Vor Jahrzehnten schrieb „La congrégation du Saint-Esprit et du Sacré Coeur de Marie à Paris", dass ihre aus Gabon zurückkehrenden Missionare berichtet hätten, die 1887 mit diesem Mittel behandelten Hölzer seien nicht mehr von Termiten angegriffen worden. Ähnlich alte Zeugnisse liegen vor von „L'Administration de l'Etat indépendant du Congo, département de l'intérieur", von einem Dockdirektor in Hongkong und anderen. J.W.LACEULLE, Onderneming „Saco Doca", Korintje, schreibt, dass eine solche Behandlung sich seit zehn Jahren bewährt habe. Am 13.5.1909 berichtet das Gouvernement of India - Public Works Department von einem Versuch in Agra, bei dem ein mit obigem Mittel behandeltes und ein unbehandeltes Holz in Termitenhügel gesteckt wurden. Das Behandelte wurde nicht angegriffen, das Unbehandelte fast völlig zerfressen. Am 6.9.1909 berichtet „The Superintendant of Police Agra (India) von einem Versuch mit drei Hölzern, von denen eines unbehandelt, eines mit Kohlenteer und eines mit Avenarius - Carbolineum behandelt war. Das erste wurde völlig, das zweite halb zerfressen, während das Dritte überhaupt nicht berührt war. Ähnliche erfolgreiche Versuche mit diesem Mittel bescheinigen das „Transvaal Department of Agriculture I in Pretoria", Uganda Railways und die Patten Blinn Lumber Co. in Los Angeles, California, das „Forest Research Institut Dehra Dun, India", und Stellen in Singapore und West Coast of Africa.

Im Laufe der Jahre wurden natürlich aus Europa und Amerika die verschiedensten Erzeugnisse für die Bekämpfung angewandt. Es ist auch für die deutschen Arbeiten ausserordentlich wertvoll, dass zwei bedeutende amerikanische Forscher auf diesem Gebiete, Geoge M. HUNT und T.E. SNYDER vom United States Department of Agriculture, vor etwa zwanzig Jahren einen gross angelegten Versuch unternommen haben. An vier Stellen der Erde, in Mittelamerika, Australien, Honolulu und Südafrika wurden Versuchshölzer, die mit den verschiedenen Bekämpfungsmitteln imprägniert waren,

Schutzmittel	Barro Colorado Island (Panamakanal-Zone)		Australien (Canberra)		Honolulu (Hawai)		Transvaal (Südafrika)	
	Zerstörungen in °/₀ nach 20 Jahren	Durchschnittl. Lebensdauer in Jahren	Zerstörungen in °/₀ nach 19 Jahren	Durchschnittl. Lebensdauer in Jahren	Zerstörungen in °/₀ nach $19^1/_2$ Jahren	Durchschnittl. Lebensdauer in Jahren	Zerstörungen in °/₀ nach 19 Jahren	Durchschnittl. Lebensdauer in Jahren
1. Steinkohlenteeröl-Erzeugnis[1])	33,3	. . .	16,7	. . .	33,3	. . .	27,2	. . .
2. Halowax[2])	71,4	. . .	85,7	. . .	71,4	. . .	33,3	. . .
3. Zinkmetaarsenit[3])	100,0	6,1	62,5	. . .	100,0	5,2	100,0	11,3
4. Zinkchlorid	100,0	1,8	100,0	6,7	100,0	3,0	100,0	1,0
5. Natriumfluorid	100,0	1,2	100,0	4,5	100,0	2,0	100,0	2,3
6. Borax	100,0	1,3	100,0	5,0	100,0	2,2	100,0	1,5
7. Nickelarsenat	57,1	. . .	87,5	. . .	37,5	. . .	100,0	9,0
8. Thalliumsulfat	100,0	3,5	100,0	6,0	100,0	2,6	100,0	1,9
9. Natriumbichromat	100,0	4,9	100,0	1,7	100,0	2,2	100,0	3,8
10. Natriumfluorsilikat	100,0	3,4	100,0	11,3	100,0	4,2	100,0	2,7
11. Nickelbichromat	71,4	. . .	100,0	1,0	100,0	5,7	100,0	2,4
12. Dinitrophenol	100,0	2,7	100,0	11,9	100,0	3,0	100,0	5,0
13. Mittel x[4])	100,0	3,1	100,0	10,7	100,0	3,2	100,0	4,8
14. Mittel y[5])	100,0	0,8	100,0	12,9	100,0	2,2	100,0	4,0
15. Weißer Arsenik	100,0	4,8	87,5	. . .	100,0	3,2	100,0	8,1
16. Anaconda-Holzschutzmittel[6])	100,0	6,3	—	—	100,0	2,5	—	—
17. Unbehandelte Kontrollen	100,0	0,7	100,0	2,3	100,0	1,7	100,0	1,6

1) Die wirksamen Stoffe dieses Mittels sind auch in den öligen Avenarius-Schutzmitteln enthalten.

2) Halowax ist ein Chlornaphthalin-Erzeugnis; nach Kofoid (Termites and termite control. Berkeley 1934) hauptsächlich Trichlornaphthalin.

3) Zinkmetaarsenit ist eine wässrige Lösung von Zinkoxyd und Arsentrioxyd (oder ähnlichen Stoffen), die mit Essigsäure angesäuert ist. Nach dem Eindringen in das Holz verdunstet die Essigsäure uns lässt das verhältnismässig schwerlösliche Zinkmetaarsenit zurück.

4) Mittel x ist ein Fluor-Phenol-Arsen-Chrom-Gemisch.

5) Mittel y ist nach Hunt & Snyder ein Fluor-Phenol-Gemisch; es enthält aber als 3. Komponente auch Chrom in geringeren oder grösseren Mengen.

6) Anaconda-Holzschutzmittel ist eine Paste, die 75-80% Arsenoxyde, besonders Arsentrioxyd, enthält. Der Rest besteht aus verschiedenen Metallen und Me-

in der Nähe von Termitenhügeln in die Erde gesteckt. Das Ergebnis nach neunzehn bis zwanzig Jahren ist nebenstehend beigefügt.

Daraus ist zu ersehen, dass die öligen Mittel erheblich besser wirkten als die Salze, und weiter, dass die mit Steinkohlenteeröl imprägnierten Pfähle bei weitem die geringsten Zerstörungen aufwiesen. An zweiter Stelle standen Pfähle, die durch Halowax, einem chlorierten Naphtalin, geschützt waren. Von den Salzen stehen an erster Stelle Arsensalze, aber deren Wirkung steht doch wesentlich hinter Halowax zurück. Die übrigen Salze haben noch eine geringere Wirkung. Aber selbst von den mit Steinkohlenteeröl getränkten Pfählen waren in Mittelamerika und Honolulu 33,3 %, in Südafrika 27,2 % und in Australien 16,7 % in neunzehn bis zwanzig Jahren zerstört. Die meisten der mit anderen Mitteln behandelten Hölzer sind aber 100 %-ig in der selben Zeit zerstört und hatten eine durchschnittliche Lebensdauer von 1-11,3 Jahren. Man sieht, dass hier noch vieles verbessert werden kann.

Unter den Steinkohlenteerölen gibt es sehr wesentliche Unterschiede in der Wirkung, die von der Zusammensetzung des Öles abhängen. Hier kann ein Versuch herangezogen werden, der unter der Leitung von Mr. PEARSON vom „Forest Research Institute" in Dehra Dun in Indien angestellt wurde. Dort wurden 10000 Schwellen am Orte in offenen Blechkästen getränkt und nach Jahren in Vergleich gesetzt mit Schwellen, die in Europa, ebenfalls mit Steinkohlenteeröl aber im Druckkessel, imprägniert wurden. Es zeigte sich, dass die in Indien auf die einfachste Weise mit Avenarius Carbolineum getränkten Schwellen eine höhere Lebensdauer hatten als die aus Europa bezogenen, technisch besser behandelten Schwellen. Dies mag daran liegen, dass bei der Herstellung des vorgenannten, speziell für die Tropen vorgesehenen Carbolineums besonderer Wert darauf gelegt wurde, dass das Mittel eine sehr hohe Siedezahl hat. Dies ist unbedingt nötig, da sonst bei der tropischen Hitze die Mittel zu rasch verdunsten und dadurch an Wirkungskraft einbüssen.

Aber auch auf anderer Basis hat ein deutsches Erzeugnis nachweisbare Erfolge im Kampf gegen die Termiten erzielt. In den Untersuchungen von HUNT und SNYDER ist bereits ein Chlornaphtalinpräparat (Halowax) genannt. Auf der gleichen Basis wurde in Deutschland das Xylamon entwickelt, von dem speziell für den Schutz gegen Termiten die Arten Xylamon TR Braun und Xylamon TR Hell hergestellt werden, bei denen hochchlorierte aromatische Kohlenwasserstoffe als besonders gegen Termiten wirksame Komponenten dem Grundstoff zugeführt wurden. Da dieses Mittel als Frass-, Berührungs- und Atemgift wirkt, ist seine termitenabwehrende Eigenschaft gegenüber einfachem Chlornaphtalinpräparat wesentlich erhöht. Besonders nach den im früheren Laboratorium für Materialuntersuchung vom Ministerium fur ökonomische Angelegenheiten in Bandoeng (Indonesien), der Boschbouwproefstation in Buitenzorg (Java) und dem Institut von Professor Dr. W. ROSENDAHL in Nysore (Vorderindien) gemachten Versuchen wurde es als ge-

eignet zur Termitenbekämpfung befunden und in hohem Masse in tropischen Ländern verwendet. Über die Ergebnisse liegen zahlreiche Anerkennungen vor, unter anderem von der Serdang Central Plantation Ltd. Soekaloewey und Balbewa Estates, von der N.V. Rubber Cultuur, Mij Amsterdam in Poeloe-Padja, vom N.V. Houthandel en Houtindustrie „Kibodas" in Soekaboemi, von der Firma Almycén Helda, Barranquilla in Columbien und anderen.

Bei den beiden genannten deutschen Mitteln ist zu erwähnen, dass sie unschädlich gegen Menschen und Haustiere sind, was gegenüber manchen Arsenprodukten und Sublimaten, die für Schwellen und Masten geeignet sein können, für Wohngebäude von besonderer Bedeutung ist.

Wie schon eingangs erwähnt, ist der Kampf gegen die Termiten international, und es werden in vielen Ländern Mittel gegen diesen Schädling hergestellt. Meine kurzen Mitteilungen sind natürlich weit entfernt davon, einen allgemeinen Überblick über die Bekämpfung zu geben, oder einen Vergleich mit Mitteln aus anderen Ländern zu ziehen; ja sie umfassen nicht einmal die gesamte Arbeit deutscher Wissenschaftler und Firmen auf diesem Gebiet. Sie sollen lediglich eine Mitteilung über einige deutsche Beiträge im Kampf gegen einen gefährlichen Holzzerstörer sein.

DISCUSSION

Mr. **ten Houten**: Ist der Herr Dr. HESPELER der Meinung, dass Termiten in unseren Gebieten ein Gefahr werden können, wo in die gemässigte Zone die Winter sehr kalt sind fur diese thermophilen Insekten?

Mr. **Hespeler**: Das Beispiel aus Hamburg zeigt, dass Termiten wenn sie einmal in die gemässigte Zone eingeschleppt sind, durchaus in dieser weiterleben und sogar neue Staaten gründen können. In Hamburg geschah dies sogar während des Krieges in völlig ungeheizten Häusern. Sie können eine Gefahr werden, wenn man sie nicht rechtzeitig bekämpft.

Ein ähnliches Beispiel sehen wir am Hausbock, (*Hylotrupes bajulus* L.) der ursprünglich im Atlas, also auch im Süden heimisch gewesen sein soll, in Nord-Europa eingeschleppt wurde und sich dort völlig akklimatisiert hat.

Mr. **Busvine** remarks: The ant *Monomorium pharaonis* L. is one example of an insect from hot countries, which is common in heated buildings in England, but does not breed out of houses. It spreads, apparently, on packing cases etc.

ÜBER FAKTOREN DER INSEKTIZIDEN POTENZ

von

W. REICHMUTH

Celle, Deutschland

Vorbemerkungen

Die Wirksamkeit von Insektiziden, ihre toxische Potenz, steht sowohl in Abhängigkeit vom Insekt als auch von der Aufbereitung der Wirksubstanz.

Die im letzten Dezennium entwickelten zyklischen Chlorkohlenwasserstoffe sind in hervorstechender Weise durch Veranlassung neurotroper Reaktionen im Organismus der Gliedertiere gekennzeichnet. Von den einzelnen Vertretern aus dem Reich der Kerfe ist bekannt, dass der Aufbau des Nervensystems je nach Art, Gattung und Familie recht unterschiedlich konstruiert sein kann. Zwischen dem verhältnismässig dezentralisierten und einfachen Nervensystem der Schabe und dem stark zentralisierten der Fliege kennen wir viele Übergänge. Sie allein bieten schon ohne Rücksicht auf sonstige biologisch-ökologische Momente zahlreiche Hinweise fur das unterschiedliche Verhalten von Insekten gegenüber gleichartigen Aufbereitungen ein und desselben chemischen Stoffes.

Die modernen synthetischen Kontaktinsektizide hat man gern unter dem Begriff „*Fussgifte*" zusammengefasst. Weitgehend unbeachtet ist es neben unterschiedlichem Extremitätenbau der Arten immer noch geblieben, dass die Motorik der Insekten mit ihren Unterschieden bei den einzelnen Arten für die Applikation und Potenz der Insektizide einen ausschlaggebenden Faktor darstellt. Der Vergleich der Haltung zum Beispiel bei Schaben, Fliegen und Wanzen während Ruhe und Bewegung klärt über unterschiedliches Benehmen der Tiere auf.

„Gangarten"

In Erinnerung an die Elementarzoologie mit ihren Beispielen von Sohlengängern, Zehengängern, Zehenspitzengängern u.s.w., lassen sich auch bei den Insekten „*Gangarten*" unterscheiden. Ein Vergleich der Tarsenhaltung von Deutscher Schabe, Fliege und Wanze ist in Abb. 1 gegeben. Diese Unterschiede mögen zum Beispiel klarmachen, weshalb die bisher gerade gegen DDT immer noch als widerstandsfähiger gegenüber anderen Insekten bezeichnete aber durchaus gegen diese Wirksubstanz empfindliche Bettwanze in den Ruf der Widerstandsfähigkeit gelangt ist. Während bei der Schabe die bekannten langen Latenzzeiten aus dem Bau des Zentralnervensystems gutenteils verständlich gemacht werden können, ist bei der Bettwanze die Lage der nervösen Angriffspunkte bei der Haltung der Tarsen sehr wesentlich. Während nämlich die konvex über dem Substrat gewölbten Tarsalglieder an einem Ende den Boden mit zwei Krallen berühten, kommt am anderen Ende lediglich das erste Tarsalglied und eine Borstenstruktur der Tibia mit dem Boden in Berührung.

Die kurzen Hinweise auf biologisch-anatomische Grundlagen mögen die Notwendigkeit gezielter Aufbereitungen toxischer chemischer Körper beleuchten. Mit der folgenden Besprechung physikalischer, chemischer und physiologischer Belange dieses Problemkreises möge rückblickend auf die angedeuteten biologisch-anatomischen Grundlagen aber auch der Abstand und der Mangel hinreichender Experimente und Erfahrungen vor Augen treten, die uns von den Möglichkeiten der Normung trennen! Es kann heute weder eindringlich noch oft genug hervorgehoben werden, dass sich die Forschung und Entwicklung auf diesem Gebiet verliert, wenn zum Beispiel vorzeitig und unzutreffend Wertungen von Wirksubstanzen gegeneinander ausgesprochen und weiteren Arbeitsplanungen zu Grunde gelegt werden.

Struktur und Grösse

Als während der Jahre 1939 – 45 für Deutschland bei der Herstellung von DDT Kapazitäts- und Konzentrationsfragen recht bedeutungsvoll geworden waren, zeigte sich in biologischen Untersuchungen zunächst mit verschiedenen Handelsprodukten, dass Verminderungen an wirksamer Substanz nennenswerten Einfluss auf die Begünstigung von Wirkungseffekten ausübten. Auf diesem Wege wurde aus der Frage nach der Konzentration ein Problem der Verteilung und Teilchengrösse der Wirksubstanz. Es wurde nachgewiesen, dass mikroskopische Haufenwerke der Wirksubstanz der feinen Verteilung kleiner Partikel, die den Sinnesorganen der einzelnen Insekten an den Füssen entsprachen, wirkungsmässig unterlegen waren.

Als ein derartiges Haufenwerk ist beispielsweise das amorphe DDT-Gebilde im beigefügten Bild (Abb. 2a) zu verstehen. Die Abbildung stellt die elektronenmikroskopische Aufnahme einer zwar Läuse – aber nicht Wanzen – wirksamen Handelsemulsion nach wässriger Verdünnung auf 0,01% Wirksubstanzgehalt dar. Der morphologische Vergleich dazu ist aus einer ebenfalls 0,01%-igen wässrigen Emulsion zu entnehmen, bei der die Wirksubstanz auf Teilchengrössen von etwa 0,1 µ und kleiner zerrissen worden sind, die vor allem auch wanzenwirksam war (Abb. 2b).

Die Methode für diese Aufbereitung, die lediglich aus DDT, Wasser und Schutzkolloid bestand, ist in folgendem Schema veranschaulicht (Abb. 3).

Entsprechende biologische Untersuchungen an *Pediculiden* auf imprägnierten Textilien (Abb. 4) liessen sich vergleichend unter Verwendung von 0,4, 0,2 und 0,1% DDT-haltigen wässrigen Flotten demonstrieren. Auf Grund der für den Effekt massgeblichen Verteilung zweckentsprechender DDT-Partikel zeigte sich, dass bei der Imprägnation mit 0,1% DDT-haltiger Flotte die Läuse nach 1' Verweilzeit mit 48-stündiger Latenz zu 100% zu Grunde gegangen waren, während für den gleichen Effekt bei den mit 0,2%-iger Flotte imprägnierten Geweben 30' Verweilzeit und bei noch stärker imprägnierten Geweben (0,4% DDT in der Imprägnationsflotte) bis zu 4^h Expositionsdauer erforderlich war.

Analoge Verhältnisse konnten bei den Versuchen mit *Cimiciden* nach Ausbringung von 8,0, 5,0, 3,0, 2,0, 0,2 und 0,1% DDT-haltigen Flotten auf Holz

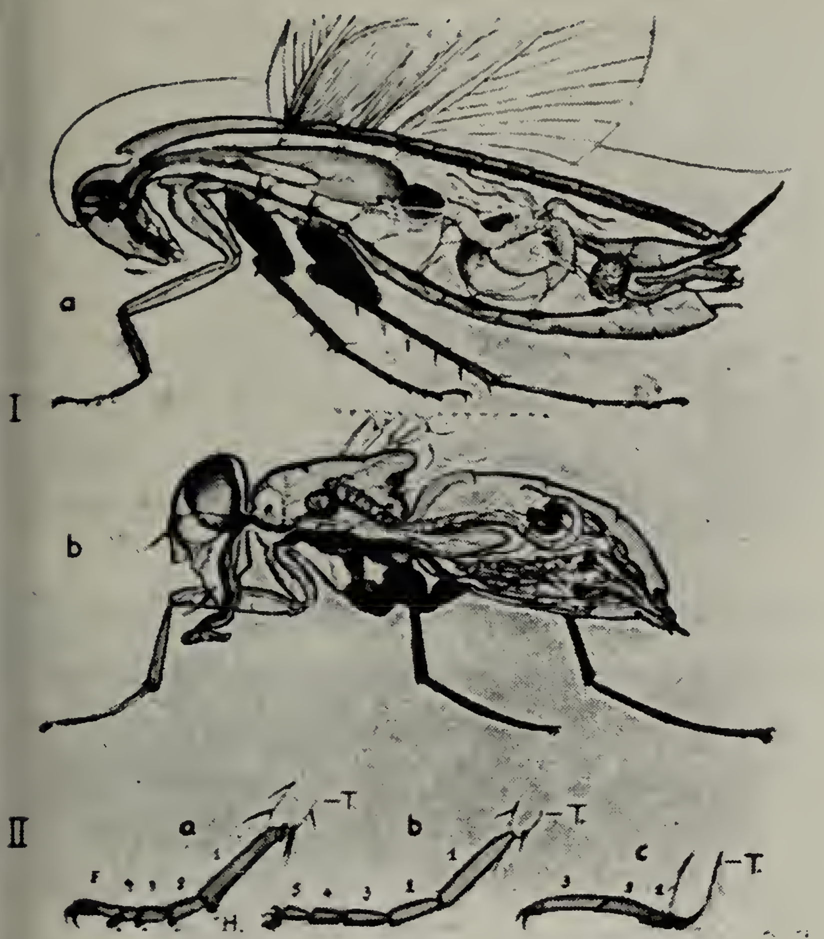


Abb. 1

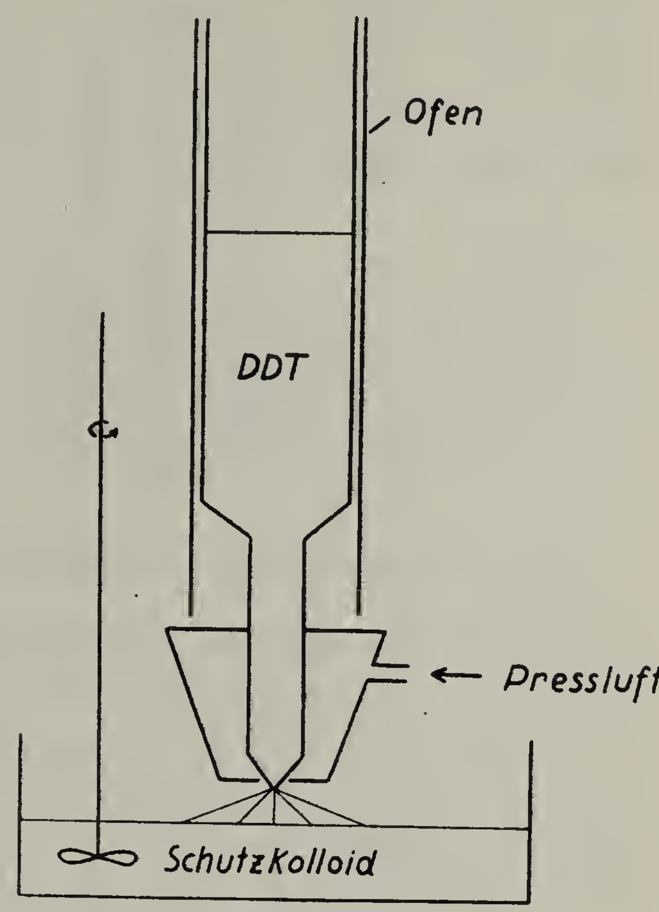
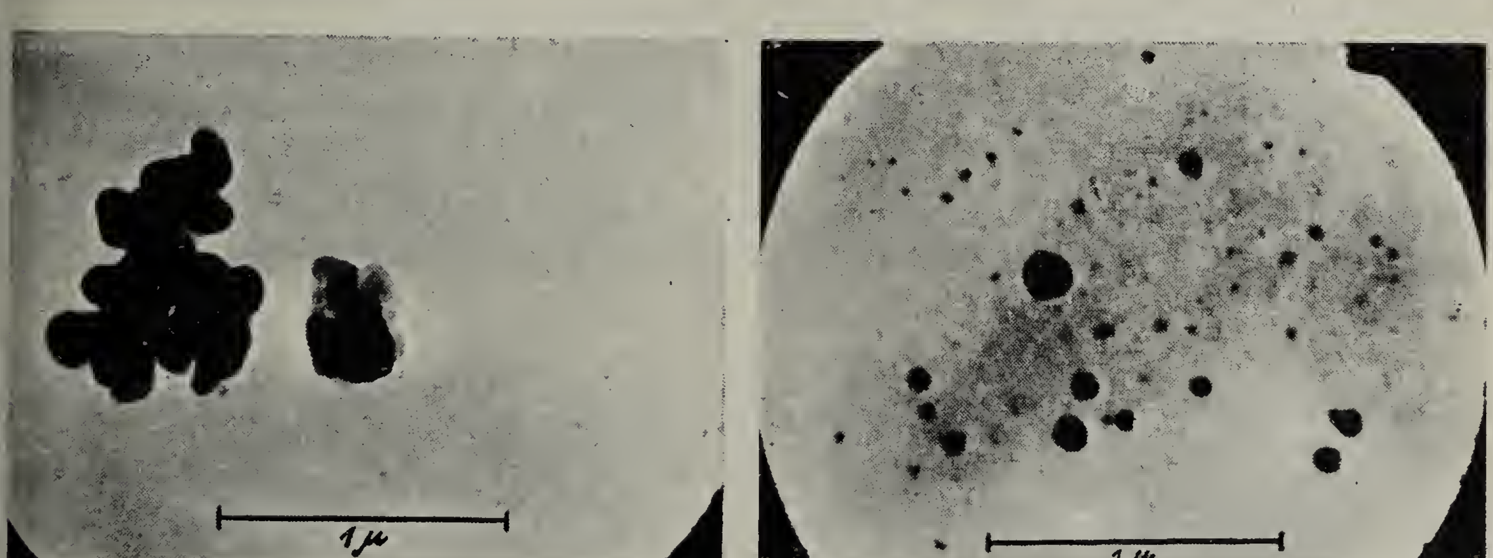


Abb. 3

Abb. 1. Anatomisch-biologische Grundlagen zur Wirkung der Fussgifte im Schema (I Nach Weber, etwas verändert).
I Nervenverlauf und Blutgefässe bei der a) Deutschen Schabe; b) Stubenfliege.
II Die Flächenberührung bei der „Gangart" der a) Deutschen Schabe; b) Stubenfliege; c) Bettwanze.
T = Schiene; 1, 2, 3, 4, 5 = Fussglieder; H = Haftballen (Zeichnung: H. John).

Abb. 3. Schema des Gerätes zur Herstellung einer DDT-Dispersion in Wasser mit Schutzkolloid (Zeichung: Dr. W. Rauch).



a Abb. 2 b

Abb. 2. Elektronenmikroskopische Darstellung von DDT-Emulsionen (Vergr. 30 000-fach). Wässrige Verdünnung auf (0,01 % Wirksubstanz von 2 verschiedenen Produkten: a) Handelsware; b) mechanisch zerteiltes DDT in Wasser mit Schutzkolloid. (Foto: Dr. Schweckendiek).

festgestellt werden (Abb. 5) Eine 100%-ige Abtötung der Bettwanzen, die nach Ausbringung von 0,2% DDT-haltiger Flotte und nach 4-stündiger Exposition der Versuchstiere mit 6-tägiger Latenz erzielbar war, konnte bei diesen Vergleichstesten selbst bei Konzentrationen von 8% DDT in den ausgebrachten Flotten nicht erreicht werden.

Isomerie

Neben der Struktur der ausgebrachten Elemente, deren Funktion bei den einzelnen Insekten sich etwa mit der von Schlüssel und Schloss vergleichen lässt, stellt die Isomerie einen Faktor insektizider Potenz dar. Ohne Zweifel ist beim HCH der Gamma-Isomere eine hervorragende Bedeutung beizumessen.

Es darf aber keineswege übersehen werden, dass die Reaktion einzelner Insektenarten nicht nur gegenüber der Gamma-Isomere sondern auch gegenüber den anderen Isomeren unterschiedlich ist. Als Beispiel für die unterschiedliche Empfindlichkeit gegen diese anderen Isomeren hat die Kleiderlaus zu gelten. Läuse konnten bei Verwendung der Alpha-Isomere als auffallend empfindlich erkannt werden und liessen sich besser als mit Gamma-Wirkstoff vernichten.

Im Zuge des Bestrebens möglichst geruchfreie technische HCH-Wirksubstanz zu gewinnen, gelangten Präparate aus reinem Gamma-HCH zur Anwendung. Es fiel aber dabei auf, dass beispielsweise bei Vergleichsversuchen an den hochempfindlichen Fliegen mit zunehmendem Reinheitsgrad ein Nachlassen in der Wirkung vor allem hinsichtlich der Dauerwirkung zu verzeichnen war. Diese Angaben beziehen sich auf Reinheitsgrade an sich hoch- Gamma-haltiger Produkte.

Sehr bald während dieser Arbeiten aufgenommene Untersuchungen über die Wirkung bestimmter Isomeren-Gemische zeigten sich Synergismen, so dass zum Beispiel Bettwanzen mit einem Zusatz von Alpha-HCH zur Gamma-Isomere besser als bei reinem Gamma-Wirkstoff erlagen. Es sei noch vermerkt, dass bei diesen Versuchen an Bettwanzen Zusätze von Delta-HCH keine Wirkungssteigerungen brachten, dass sich das Restkörpergemisch im Kristallisationsruckstand aus dem rohen Chlorierungsprodukt aber als Synergist erwies.

Bei analogen Versuchen unter Verwendung von Schwelprodukten konnte ermittelt werden, dass indifferente schmelzpunkterniedrigend wirkende Mischungen mit Gamma-HCH nicht zum Synergismus führten, sondern dass vielmehr Isomerengemische und dabei zum Beispiel bestimmte Mischungsverhältnisse von Gamma- und Alpha-HCH die Effekte bei Fliegen entscheidend beeinflussten.

Die Ergebnisse aller Versuche zu diesem Thema überblickend mag zusammenfassend hervorgehoben sein, dass bei den vielfältigen Kombinationsmöglichkeiten, welche die bisher bekannten HCH-Isomeren offenhalten, eine noch sehr weitgehende Spezialisierung der präparativen Aufbereitungen in Betracht zu ziehen ist.

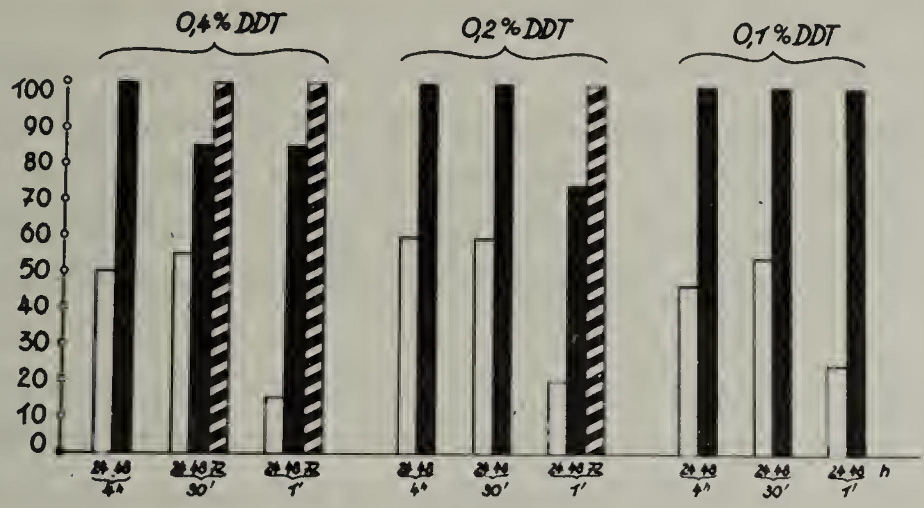


Abb. 4. Die Reaktionen von Kleiderläusen auf Textilgut mit verschiedenem DDT-halt.
Ordinate: Abtötungsprozent; Abszisse: Latenzzeiten nach Exposition von 4^h, 30' d 1' (Zeichnung: Prof. Dr. A. Koch).

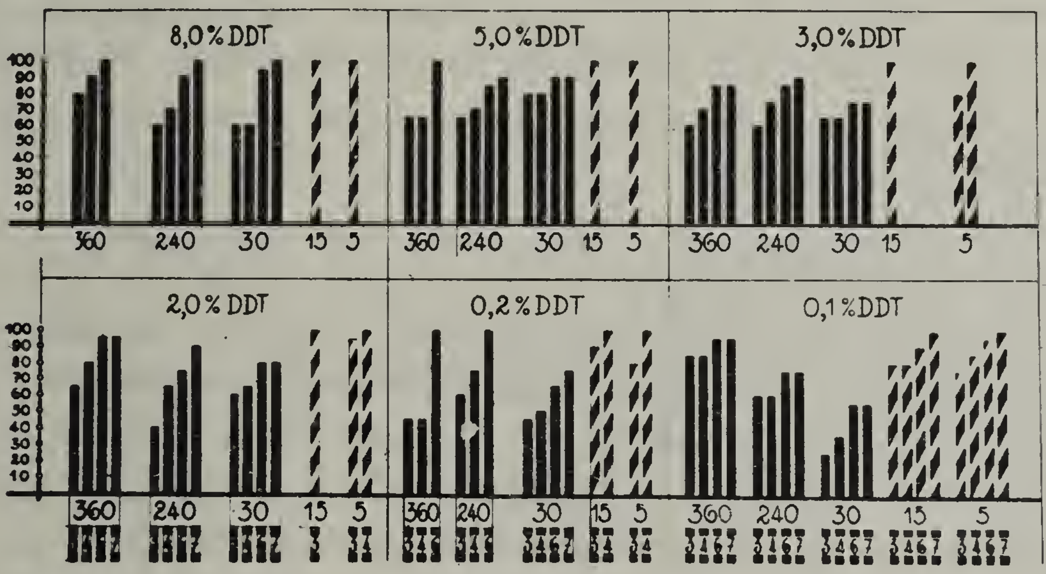


Abb. 5. Das Verhalten von Bettwanzen auf Holzbrettchen, mit gleichen Flotten-ıgen verschiedenen DDT-Gehaltes behandelt.
Ordinate: Abtötungsprozent; Abszisse: Verweildauer in Minuten und Effekte nach 4-, 6- und 7-tägiger Latenz.
Bei Exposition von 5' und 15' sind die Bettwanzen ununterbrochen in Bewegung halten worden. (Zeichnung: Prof. Dr. A. Koch).

satzstoffe

Ein weiterer Faktorenkreis für die zielstrebige Auswertung insektizider :enzen ist durch die Einflussnahme von Zusatzstoffen, insbesondere Sta-isatoren, gekennzeichnet. Allgemein lässt sich auch hier vorausstellen, s oft ein Wechselspiel zwischen den Effekten bei der Initial- und Dauer-kung besonders auffällt. Es hat sich vielfach ergeben, dass Steigerungen Initialwirkung mit Einbussen an Dauerschutz und Herabsetzungen der :zeffekte mit einer Förderung der Dauerwirkung einhergeben. Hier den ıtigen Weg zu finden ist Aufgabe umfangreicher und mühevoller Experimen-ırbeit.

a. Emulsionen und Lösungen

Ergebnisse mit 1,2%DDT enthaltenden wässrigen Emulsionen ein und desselben Präparates unterschiedlicher Qualität infolge ungleichmässiger präparativer Aufbereitung mögen die Bedeutung der Zusatzstoffe für den biologischen Effekt demonstrieren *). Während bei der Struktur der einen Emulsion wochenlange Wirkung nach Ausbringung gegen Fliegen zu beobachter war, blieb dieses Ergebnis bei der anderen Emulsion bereits nach längstens 48 Stunden aus.

So ist vorstellbar, dass die heute einsatzfähigen Präparate der einschlägigen Industrie mühevoll erarbeitete Spezialitäten mit sehr subtilem Charakter darstellen und sich auch nur schwerlich in ein System eingliedern lassen das mehr als ein Orientierungsmittel sein kann.

Gerade die Fixierung des HCH-Wirkstoffes bietet vielerlei Widerstände insbesondere dort, wo zum Beispiel auf die Bekämpfung der Bettwanzen abgezielt wird. In diesem Zusammenhang liegen gute Vergleichmöglichkeiten zwischen den ähnlichen Präparaten „Parex" und „Parex-Spezial" vor Während das eine, selbst als Nebel ausgebracht, z.B. Deutsche Schabe noch nach über 100 Tagen mit Sicherheit tötet, aber nicht wanzenwirksan ist, zeigt das andere unter gleichen Bedingungen anhaltende spezifisch Wirksamkeit gegen Bettwanzen.

b. Insektizide Farben

Besondere Stabilisierung, nicht nur von DDT, sondern gerade auch vo HCH, die mehrjährigen Dauerschutz gegen verschiedene Insekten gewähr leistet, ist u.a. in den Aufbereitungen mit Farbanstrichen und Tapetendruck farben erkannt worden. Auch hier muss aber auf die Spezialentwicklung be sonders Wert gelegt werden und vor fachlich ungerechtfertigten laienhafte Mischungen gewarnt werden. Beistehendes Schema (Abb. 6) demonstriert de Wirkungsvergleich von zwei DDT-Farben an Stubenfliegen, die mit verschie denen Bindern hergestellt sind. Während der eine Binderzusatz, wie er i dem von der Biologischen Bundesanstalt amtlich anerkannten Produkt „IMÄ LUX" enthalten ist, im 8'-Expositionstest bis zur hier wiedergegebene Alterung von rd. 190 Tagen regelmässig 100%-ige definitive Rückenlage der Tiere zur Folge hat, blieben bei einer anderen sonst gleichartigen Bin derfarbe derartige Effekte aus. Analoges ergab sich bei Vergleichen zwei DDT-Farben (Abb. 7), die mit verschiedenen Leimen hergerichtet waren. Be Vergleich zwischen Leim- und Binderfarbe fällt ausserdem auf, dass di bisher besten Binderfarben den bisher als am zweckmässigsten ertestete Leimfarben überlegen sind. Was für DDT hier ermittelt wurde, gilt im Ve gleich in noch stärkerem Masse für Farben auf HCH-Grundlage, Ergebniss von Untersuchungen an Emaillelack-, Öllack- und Binderfarben der Firm Iversen und Mähl, Hamburg, die auch an Leimfarben vorgenommen wurden zeigten nicht nur, dass sich Emaillelack- und Öllackfarbe mit je drei ve

*) Abbildung in 5) des Literaturverzeichnisses.

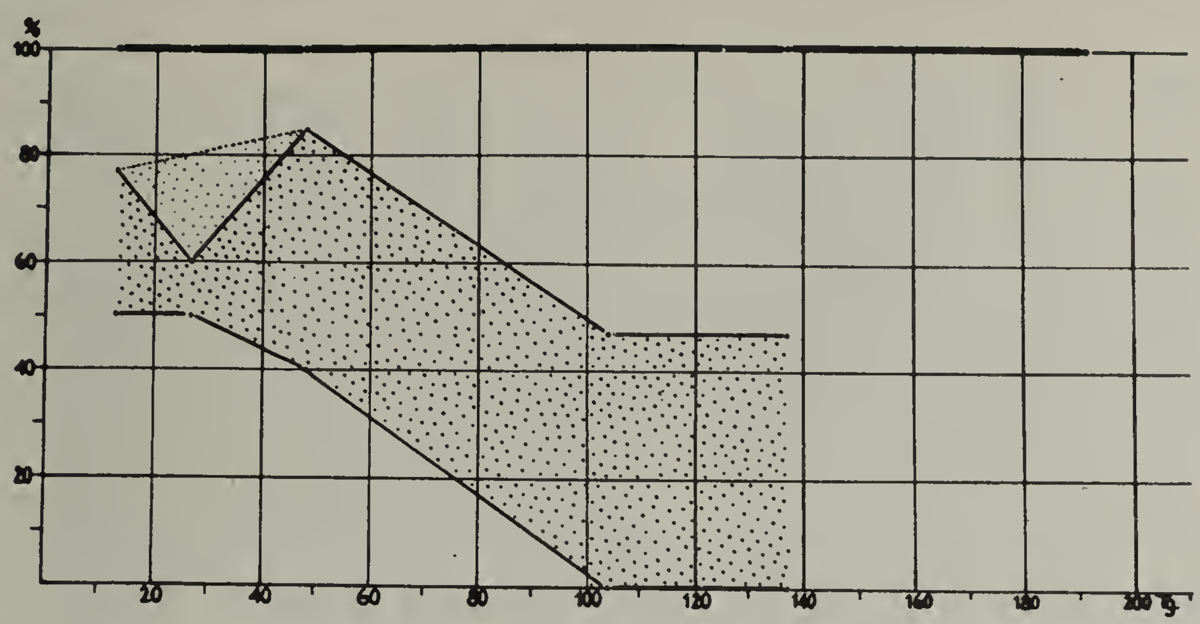


Abb. 6

Abb. 6. Das Verhalten von Stubenfliegen auf zwei DDT-Farbanstrichen mit verschiedenen Bindern im Verlauf von 190 Tagen. Während die eine DDT-Binderfarbe bei 8'-Exposition regelmässig 100 % DR ergab, erwies sich die andere DDT-Binderfarbe als unzureichend. Streuungsbereich der Ergebnisse zwischen Minimal- und Maximalwerten gepunktet.
Ordinate: DR – Prozent; Abszisse: Substratalter. (Zeichnung: Dr. E.Mosebach)

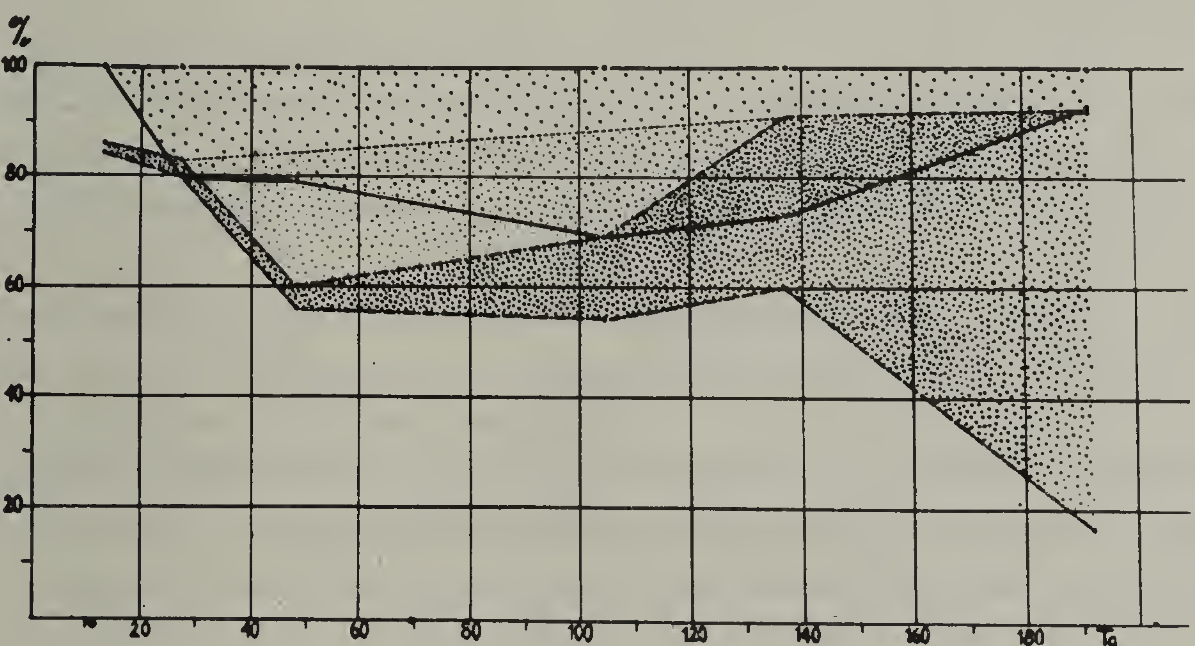


Abb. 7

Abb. 7. Die Reaktion von Stubenfliegen auf 2 DDT-Farben mit verschiedenen Leimen (weit und eng gepunktet) im Verlauf von 190 Tagen.
Ordinate: DR – Prozent nach 16' Exposition; Abszisse: Substratalter (Zeichnung: Dr. E.Mosebach).

schiedenen Wirksubstanzkonzentrationen in den einzelnen Expositionstesten voneinander im Ergebnis unterscheiden, sondern wiesen auch gegenüber der Binder- und der Leimfarbe Diverganzen auf (Abb. 8). Auf Binder- und Leimfarben sind kürzere Verweilzeiten bis zur 100 %-igen DR ausreichend als bei den Filme bildenden wirkstoffgleichen Emaillelacken und Öllackfarben. Es war wiederum auffallend, dass nicht bei allen HCH- und DDT-Aufbereitungen z.B. (bei nachweislicher Schaben- oder Fliegenwirkung) Wanzenwirkung bestand. Bereits im Kriege konnten gemeinsam mit der Firma Böhme Fettchemie aber schon über 4 Jahre wanzenwirksame DDT-Ölfarben ausgearbeitet werden. So sind auch bei diesem Sektor nicht nur die Provenienz des

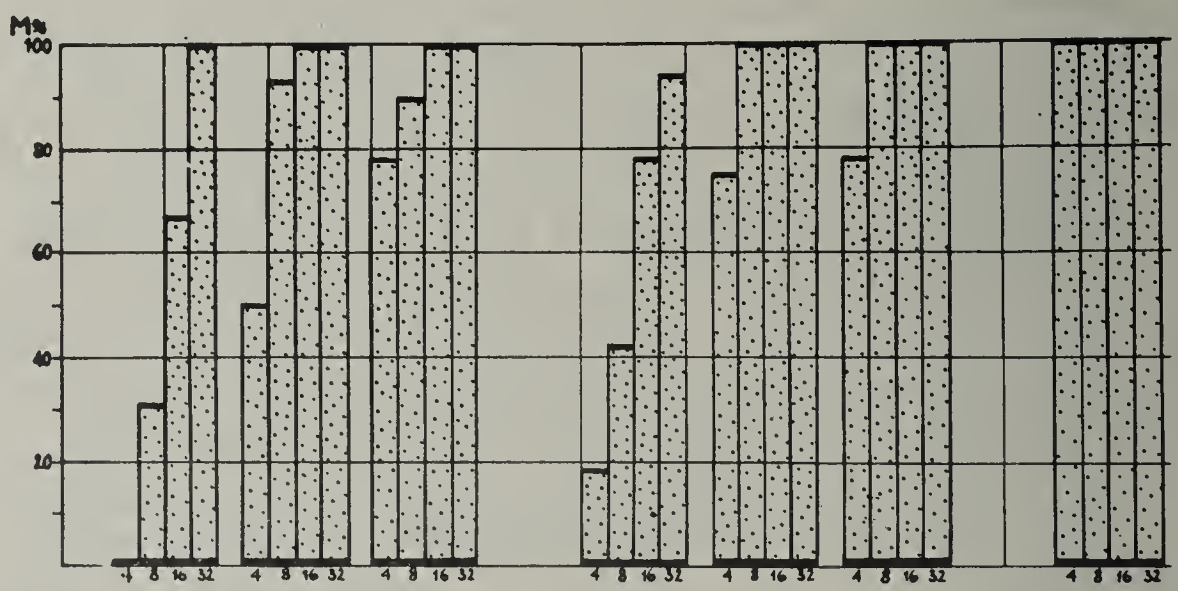


Abb. 8

Abb. 8. Die Wirkung von stark gealterten a) Emaillelack-, b) Öllack-, c) Binder-Farben, mit je 3 verschiedenen HCH-Isomerengemisch-Konzentrationen auf Stubenfliegen.

Ordinate: DR in Prozent, Abszisse: Verweildauer in 4, 8, 16, 32' (Zeichnung: Dr. E.Mosebach).

Wirkstoffes, seine Einbringung in die Farbe als Substanz oder in Lösungen, sondern auch die Farbkomposition und die Pigmente für den Endeffekt von sehr ausschlaggebender Bedeutung. Diese Erkenntnisse haben einen weiteren wesentlichen Anwendungsbereich erschlossen.

Das mit kleiner Auswahl von Ergebnissen aufgezeigte Wechselspiel zwischen biologisch-anatomischen Grundlagen für den Angriff der Insektizide und Strukturen der Wirksubstanz, der Isomerie und als Stabilisatoren wirkender Zusatzstoffe mit ihren Auswirkungen für die erstrebten toxischen Effekte möge schliesslich, aber nicht zuletzt, dazu beitragen, im Dienste des Fortschritts die biologische, chemische, physikalische und physiologische Blickrichtung noch mehr als bisher zu koordinieren.

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DISCUSSION

Mr. **Busvine**: Did Dr. REICHMUTH actually find the other isomers of BHC more toxic than the gamma? In mixtures of isomers potentiation may be merely due to a physical factor (lower melting-point: better contamination of the insect). Were the tests made by direct application to the insects, or by insects walking on treated surfaces?

Mr. **Reichmuth**: Es wurde betont, dass nicht generell andere HCH-Isomeren als die des Gamma sich toxischer erwiesen, sondern dass die toxischen Potenzen einzelner Isomeren gegenüber verschiedenen Insekten unterschiedlich sind und mitunter der Gamma-Isomere gleichkommen. An *Pediculiden* wurde erkannt, dass sie gegenüber Alpha-HCH empfindlicher als gegen Gamma-HCH sind.

Es liess sich experimentell nachweisen, dass gerade nicht Schmelzpunkterniedrigung oder sonstige physikalische Faktoren die Wirkungspotenzierung in Isomerengemischen bestimmten, sondern dass die Mischungsanteile der Isomeren für den Synergismus entscheidend sind, was sich z.B. sowohl beim Eintauchen oder Einnebeln von Bettwanzen und Läusen als auch bei Expositionen auf imprägnierten Substraten (Textilien, Holzplatten, Fliesspapier) ergab und bestätigte.

Mr. **Gasser**: Haben Sie ebenfalls einen Synergismus festgestellt in Mischprodukten von DDT und HCH, wie Sie einen solchen festgestellt haben für Alpha- und Gamma-Isomere von HCH?

Mr. **Reichmuth**: In Mischprodukten von DDT und HCH konnte bisher weder bei Pulvern noch bei Emulsionen und Lösungen an Hand von Läusen, Wanzen, Fliegen, Schaben ein Synergismus festgestellt werden, wie es von den HCH-Isomeren berichtet wurde.

DIE BEKÄMPFUNG DER VORRATSSCHÄDLINGE DURCH OBERFLÄCHENAKTIVE PULVER

von

Friedrich ZACHER
Berlin-Steglitz

In den letzten Jahrzehnten hat infolge wirtschaftlicher und politischer Unruhen sich immer wieder die Notwendigkeit ergeben, dass in vielen Ländern der Erde grosse Mengen von Lebensmitteln für lange Zeiträume als Lebensmittelreserven eingelagert werden mussten. Damit ist aber auch die Gefahr der Vernichtung durch Vorratsschädlinge in den Vordergrund des Interesses gerückt. Besonders bei Getreide ist der Dauerschutz gegen Schädlinge ein Problem von grösster wirtschaftlicher Bedeutung und ich habe mich damit schon seit vielen Jahren beschäftigt.

Die Entwicklung der hochwirksamen modernen Kontaktinsektizide hat ja auf vielen Gebieten der Schädlingsbekämpfung revolutionierend gewirkt und es schien auch eine Zeit lang so, als ob sie berufen wären im Vorratsschutz alle anderen Mittel zu verdrängen. Aber auch diese Mittel, so vorzüglich ihre Wirkung ist, haben für ihre Verwendung Grenzen. Entsprechend ihrer Natur können sie bei Zumischung zum Getreide einen zwar sehr wirksamen, aber zeitlich doch nur begrenzten Schutz gewähren. Die Dauer der Wirkung wird man fur DDT höchstens mit einem Jahr ansetzen können, während bei HCH kaum eine längere Wirkung als etwa 2- 3 Monate zu erwarten ist. Dazu kommen dann noch unter Umständen hygienische Bedenken, da die Kontaktinsektizide nicht unbedingt ungiftig und ungefährlich sind. Nach Feststellung von DUNBAR vertragen Ratten Futter mit 1/1000000 DDT, während bei einer Konzentration von 5/1000000 bereits Leberschäden auftraten. Für HCH sind die Untersuchungen noch nicht abgeschlossen, jedoch ist in England eine grosse Enquete des Gesundheitsministeriums im Gange. In USA wird nach MÜLLER-KÖGLER die Zumischung solcher Pulver eindeutig abgelehnt.

Es ist ja ganz allgemein so, dass mehrere Methoden nebeneinander notwendig und wünschenswert sind, die verschiedenen Zwecken angepasst werden können. Deshalb haben die oberflächenaktiven Pulver immer wieder Interesse gefunden. Sie haben zunächst einmal den grossen Vorteil, dass sie sich chemisch und physikalisch nicht verändern. Das ist sowohl experimentel als auch in der Praxis erprobt. In Italien hat CANDURA die unveränderte Wirksamkeit von Kieselgur, das dem Getreide beigemischt war, 12 Jahre hindurch geprüft und die unverminderte Wirksamkeit gegenüber immer frisch zugesetzten Insekten festgestellt. GAY führte in Viktoria (Australien) langfristige Versuche in Speichern mit Magnesit und Dolomit aus und fand, dass die Schutzwirkung nach 18 Monaten unverändert war. In hygienischer Hinsicht ist es bedeutungsvoll, dass die oberflächenaktiven Pulver, die bisher zur praktischen Anwendung kamen, ungiftig sind. Allerdings wurde bezüg-

lich des Quarzmehls von der Seite der Gewerbemedizin behauptet, dass dadurch die Gefahr der Silikose hervorgerufen würde, jedoch ist die Meinung der Mediziner durchaus nicht einheitlich. In Deutschland wurde allerdings mit der Begründung der Silikosegefahr die Verwendung von Quarzmehlpulvern zur Schädlingsbekämpfung 1941 verboten. Es war daher erforderlich andere Pulver mit gleicher insektizider Wirkung zu finden, für die der Verdacht der Silikose nicht besteht. Ich habe im Laufe der Jahre eine sehr grosse Zahl, etwa 150, verschiedene Stoffe geprüft. Von diesen töteten 94 Substanzen in genügend feiner Vermahlung 100 % der damit behandelten Kornkäfer in höchstens 6 Tagen ab. Für praktische Zwecke kommen davon nur wenige Stoffe in Betracht, weil dabei sehr viele andere Momente zu berücksichtigen sind. Am aussichtsreichsten erscheint bisher die Verwendung von Aluminiumoxyd, Magnesit, Vivianit und anderen Phosphaten.

Bei der Anwendung der oberflächenaktiven Pulver muss die Einstellung des Getreidehandels berücksichtigt werden. Für diesen sind Griff und Glanz des Getreides sowie das Hl-Gewicht als Qualitätsmerkmals von grosser Bedeutung. Gerade diese Merkmale werden aber durch die Mischung des Getreides mit oberflächenaktiven Pulvern wesentlich verändert. Das Hl-Gewicht von Weizen wurde durch Zumengung von 0,1 % Al_2O_3 von 79,9 kg auf 75,40 gesenkt. Überraschend war es aber, dass selbst nach weitgehender Entfernung des Pulvers durch Absieben oder Aspiration das Hl-Gewicht nicht etwa wieder stieg, sondern, jedenfalls infolge Aufrauhung der Schale, noch weiter sank und zwar auf 73,45 bzw. 74,95. Die gleiche Erscheinung ergab sich noch im verstärkten Masse bei Beimischung von 1 % Al_2O_3 und auch bei Magnesit war es nicht anders, so dass also bei Anwendung dieser Mittel das Hl-Gewicht als Bewertungsmasstab ausscheidet. Die Versuchsanstalt für Getreideverarbeitung hat sich auch früher schon mit diesem Problem beschäftigt. MOHS hat vorgeschlagen, an Stelle des Hl-Gewichtes das spezifische Gewicht als Bewertungsmasstab einzuführen, das nicht verändert wird. THOMAS wies darauf hin, dass das 1000-Korngewicht und die Glasigkeit, die gleichfalls nicht verändert werden, genugende Bewertungsmasstäbe geben. BRÜCKNER schlägt als Basis der Bewertung die Feststellung des Trockengewichts vor.

Über die Wirkung der oberflächenaktiven Pulver bei ihrer Anwendung in der Praxis hat es von jeher lebhafte Kontroversen gegeben. COTTON und WAGNER waren 1941 der Meinung, dass inerte Pulver wenig Wert hätten und giftige keineswegs empfohlen werden könnten. COTTON und FRANKENFELD haben dann 1945 Magnesium-Oxyd als ungiftiges Mittel zum Schutz von Samen empfohlen, da es nicht nur insektizid, sondern auch abschreckend wirkt und ausserdem den Samen ein sauberes und gefälliges Aussehen gibt. Dieselben Autoren empfehlen 1949 als besonders wirksames Schutzmittel für Schüttbodenlagerung in Bauernspeichern ein Kieselsäureaerogel, das keine Silikose verursachen soll. In Italien hat CANDURA Kieselgur, GRANDORI Bentonit empfohlen. Am wichtigsten sind aber die Ergebnisse der Getreidekonser-

vierung in Australien. WILSON (1946) hatte bei Weizen, dessen oberste, 1 cm dicke Schicht mit 1½ % Magnesit gemischt worden war, nach einem Jah gegenüber unbehandelten Getreide einen Käferbefall von 1 : 151. In der Praxi musste die Behandlung grosser Lagerstätten in Australien allerdings durcl örtliche oberflächliche Begasung kleiner Käferherde unterstützt werden. Es ist aber als grosser Erfolg der Anwendung von oberflächenaktiven Pul vern anzusehen, dass Millionen von Bushel Weizen nach Angabe von WILSO (1946) in einer 3-jährigen Lagerungszeit praktisch unbeschädigt blieben un vom Handel ohne Preisabschlag aufgenommen wurden.

In Deutschland lagen für die Quarzmehlpräparate bis zu ihrem Verbot sel gute Ergebnisse vor, so dass sie nach sehr rigoröser Prüfung amtlich ane kannt wurden. Besonders hatte die Heeresverwaltung in ihren Magazine festgestellt, dass das eingestäubte Getreide nicht nur käferfrei blieb, son dern auch höher geschüttet werden kann, ohne warm zu werden.

Die oberflächenaktiven Pulver wirken als Vorbeugungsmittel besonder gut, da sie nicht nur abstötend, sondern auch abschreckend wirken. Da habe ich bereits in Stockholm bezüglich des Quarzmehles nachgewiesen Es gilt aber in gleichem Masse auch für Aluminiumoxyd und Magnesit. Be der gleichen Versuchsanordnung, wie ich sie in Stockholm mitgeteilt habe waren im unbehandelten Korn 87,8 %, in dem mit 1 % Al_2O_3, 9,9 % währenc die entsprechenden Zahlen für $MgCO_3$ 80 % und 18,4 % sind. Diese ab schreckende Wirkung ist auch bei Pulvern von geringerer oberflächenaktive Wirkung in gleichem Masse feststellbar, z.B. bei Specksteinmehl.

Eine Anwendungsform der Aktivpulver, die sich in Deutschland bewäh hatte, solange die Verwendung von Quarzmehl erlaubt war, ist die Isolie rung der Getreidehaufen durch Umgebung mit Pulverwällen, die als „Naaki wall" bezeichnet wurden. Hierzu wurde das Pulver in steilwandigen Wälle von 10 cm Breite verwandt. Auch GAY (1947) empfiehlt die Verwendung z Schutzstreifen. Nach seiner Angabe ist ein 30 cm breiter Streifen von Magne sit ausreichend und zwar muss er in periodischen Abständen von etwa Woche geharkt werden, um die Verkrustung zu verhüten. In diesem Zusam menhang möchte ich darauf hinweisen, dass unter den Pulvern grosse Un terschiede in der Schnelligkeit der Wirkung bestehen. Ungeachtet der end gültigen Tötung ist z.B. bei Vivianit die Initialtoxizität sehr gross. Die Läh mungserscheinungen treten viel rascher auf als selbst beim wirksamsten Al_2O_3. Dadurch wird ein solches Pulver für die Herstellung von Verbreitungs-schranken besonders wetvoll.

Welche Substanzen können nun als oberflächenaktive Pulver insektizi wirken? Um einen Überblick zu gewinnen und eine Bewertung vornehmen zu können, haben ich die Substanzen, wie man aus der Tabelle I sehen kan in 7 Gruppen eingeteilt und zwar I Metalle, II Oxyde, III Karbonate, IV Ge steinsmehle, V Techn. Produkte und Abfallstoffe, VI Kohlen, VII organische Stoffe. Ich habe dann oben die prozentuale Lebensdauer der behandelte Tiere eingetragen und zwar bezeichnet in Prozenten der Lebensdauer de

Einwirkung oberflächenaktiver Pulver auf den Kornkäfer
(*Calandra granaria* L.)

% L.D.	1 – 10	11 – 20	21 – 30	31 – 40	41 – 50	51 – 60	61 – 70	71 – 80	81 – 90	91 – 1000
I Metalle							Sb	Cu, AL	Mg	AL
II Oxyde	AL_2O_3	CuO AL_2O_3 SiO_2 MgO	AL_2O_3 SiO_2 MgO	MgO	MnO Mn_2O_3 La_2O_3 ZrO_2	ZnO		Fe_2O_3		AL_2O_3
III Karbonate			$CuCO_3$	$ZnCO_3$ $CaCO_3$	$MgCO_3$	$MgCO_3$ $MgCO_3$ $CaCO_3$	$(BiO_2)CO_3$			
IV Gesteinsmehle		Magnesit Vivianit Bentonit Olivin	Magnesit Dolomit Porphyr Bauxit Vivianit Bentonit Feldspat Quarzspat Korund Raseneisenerz Minette	Bauxit Basalt Bentonit Marmor Talkum Talkstein	Graphit Serpentin Kalkspat Talkstein Speckstein			Bentonit		Bentonit Kryolith Talkum
V techn. Prod.	Kieselgel E	Kieselgel E Kieselgel I Ton	Kokspulver Kieselgel II Neutralglas Tonerde III Ziegelmehl	Brikettasche Kieselgel I Kieselgel III Koksasche Rotschlamm	Holzasche Glaspulver osm.geschl.Kaolin Rotschlamm			Glaspulver	Brikettpulver	
VI Kohlen	A – Kohle M Clarocarbon	A – Kohle B A – Kohle C A – Kohle E Knochenkohle Holzkohle	Zucker-Kohle Silikat-Z-Kohle Hämin-Kohle Neutralrot-Kohle Bismarckbraun-Kohle Safranin-Kohle			Braunkohle	Braunkohle	Steinkohle		
VII org. Stoffe							Schallplatten- schleifstaub Wofatit P 21,23	Nitrozellulose Wofatit F	Wofatit 22	Hämin Safranin Neutralrot Bismarckbraun Oxychinolin phos.

Tabelle I

unbehandelten Kontrolltiere. Dabei ergibt sich die völlige Unwirksamkeit von Metallstaub und von Staub organischer Verbindungen. Dagegen fallen durch ausserordentliche starke Wirkung Aluminiumoxyd, Kieselgel und Aktivkohle auf, also besonders gute Adsorbentien. Da Aluminiumoxyd auch unter den am schlechtesten wirkenden Stoffen auftritt und ein ähnlich krasser Unterschied in der Wirkung z.B. auch bei Talkum vorkommt, scheint es so, als ob die chemische Zusammensetzung weniger ausschlaggebend ist, als die physikalische Beschaffenheit. Wenn Bentonit auch sehr grosse Unterschiede aufweist, so ist dabei zu beachten, dass dieser auch chemisch, je nach der Herkunft, recht verschieden sein kann. In meinen Versuchen wirkte jedenfalls der italienische Bentonit wesentlich besser als der sudetenländische. Bei den Aktivkohlen ist ihre Adsorptionsfähigkeit offenbar massgebend für ihre insektizide Wirkung.

Es wird notwendig sein, die vielen als wirksam erkannten Stoffe zunächst einmal daraufhin zu prüfen, wie die Qualität des Getreides beeinflusst wird. Das ist bisher auf meine Veranlassung hin von der Versuchsanstalt für Getreideverwertung für Aluminiumoxyd und Magnesit geschehen. Die Ergebnisse bezüglich des Hl-Gewicht habe ich bereits mitgeteilt. Al_2O_3 kann durch Sieben oder durch Sieben und Waschen praktisch vollständig entfernt werden, während nach der Aspiration noch Spuren am Korn haften bleiben. Infolgedessen zeigen Mehle aus aspirierten Korn die höchsten Aschenwerte. Im Backversuch wurde bei Mehl aus behandeltem und unbehandeltem Getreide kein Unterschied festgestellt. Alle Gebäcke erhielten bei der Beurteilung auf Ausbildung und Beschaffenheit von Kruste und Krume, sowie auf Geschmack und Säuregrad 26-27 Wertpunkte von 30 Punkten als Höchstpunktzahl. Damit ist also festgestellt, dass ein gut backfähiger Weizen durch die Behandlung mit Al_2O_3 nicht geschädigt wird. Es wird weder der bäckereitechnische Arbeitsprozess noch das fertige Gebäck ungünstig beeinflusst. Bei Magnesit ist das Verhalten bezüglich der Aschewerte ganz entsprechend dem bei Aluminiumoxyd. Bei den Backversuchen ergab es sich aber, dass die gute Entfernung des Magnesites ausserordentlich wichtig ist. Wenn das Mehl aus vor der Vermahlung nicht gereinigtem Getreide noch grössere Mengen Magnesit enthält, so bleiben die Gebäcke klein, zeigen keine ansprechende Krustenbildung. Die Krume ist gelblich-grünlich verfärbt, riecht unangenehm und das Gebäck wird durch beissenden Nachgeschmack ungeniessbar. Diese Nachteile sind sogar bei dem mit nur 0,1% Magnesit behandelten Weizen, wenn auch in schwächerer Weise, vorhanden. Wenn dagegen das Mehl aus Getreide hergestellt wird, aus dem das Magnesit durch verschiedene Behandlungsweisen entfernt wurde, so unterscheidet sich das Gebäck nicht vom normalen Gebäck. Die Punktbewertung ergab hierbei 27 Punkte. Diese beiden Untersuchungen zeigen, dass vor der praktischen Verwendung irgendwelcher aktiver Pulver eine solche Prüfung der Mehlbeeinflüssung unbedingt erforderlich ist. ZINCKERNAGEL und GASSER (1946) sagen, dass das Wirkungsprinzip der inert dusts und des Geigy 33 das gleiche sei, jedoch sei

der Vorteil des Kontaktinsektizides darin zu sehen, dass nur die kleinere Menge von 1 ‰ gegenüber 1 % bei Aktivpulvern dem Getreide beigemischt werden müsste. Das ist insofern überholt, als ich mit Al_2O_3 auch mit 1 ‰ Erfolg erzielt habe. Für Silica-aerogel geben COTTON und FRANCKENFELDT als Mindestmenge für Getreide mit 12 % H_2O nur 0,025 %, für Getreide mit 14 % 0,05 % an. Es ist zu erwarten, dass noch andere hochwirksame Aktivpulver gefunden werden können, wenn erst die theoretische Grundlage genügend geklärt ist.

Das ist aber z.Zt. noch nicht der Fall, trotzdem sich zahlreiche Forscher schon damit befasst haben. Meine ursprüngliche Theorie (1930), dass lediglich die Vergrösserung der Oberfläche durch die anhaftenden Pulver den starken Wasserverlust verursachen, wird von PARKIN (1944) abgelehnt. Dieser vertritt vielmehr die Ansicht, dass die Adsorption einer lipoidartigen Schutzschicht der Epicuticula durch die Pulver die Durchlässigkeit für Wasser steigere. Dieser Ansicht habe ich mich 1948 angeschlossen mit der Ergänzung, dass nicht nur eine Adsorption, sondern auch eine Veränderung des kolloidalen Zustandes der Lipoide und dadurch ein Wechsel von Hydrophobie zu Hydrophilie eintrete. Jedenfalls werden durch die Einwirkung der Aktivkörper Veränderungen im physiologischen Zustand der Tiere hervorgerufen, die nicht reversibel sind. Der Wasserverlust setzt sich auch dann fort, wenn die Pulver durch Abwaschen entfernt werden. Diese Deutung erscheint mir wahrscheinlicher als die Theorie von WIGGLESWORTH, der die Ansicht vertritt, dass der Wasserverlust durch rein mechanische Verletzung oder Abrasion der Epicuticula zu erklären wäre. Dagegen spricht folgendes:

1. völlig weiche Pulver, die keine Verletzung hervorrufen können, wie Kohle aus Hämin, Safranin, Neutralrot usw. wirken;
2. die Wirkung ist unabhängig von der Härte. Pulver aus Korund (Härte 9) wirkt nicht stärker als z.B. aus Feldspat (Härte 3);
3. Metallpulver sind ohne Wirkung;
4. die Wirkung wird durch Ausglühen (Kalzinieren) verstärkt;
5. der Effekt tritt auch bei bewegungslosen, betäubten Tieren ein.

Eine direkte Beziehung zwischen der Kapillarwirkung der Pulver und der Abtötungszeit besteht nicht, wie wir durch Modellversuche nachweisen konnten. Die Durchlässigkeit einer Wachsschicht für H_2O wurde gesteigert durch Bestäuben

mit SiO_2	auf das	10-fache	(10-30)	mit Mg auf das 6-fache
Kalkspat	auf das	3-fache	(40-50)	mit Zn auf das 8-fache
Al_2O_3	auf das	5-fache	(1-20)	in dünner Schicht
	auf das	4,5-fache		in dicker Schicht.

Es sind also, wie ich bereits in Stockholm ausführte, auf jeden Fall 2 Komponente der Wirkung zu untersuchen, eine physikalisch und eine physiologisch-chemisch bedingte, die beide noch einer näheren Aufklärung bedürfen. Das wird aber nicht ohne die Mitwirkung von Chemikern und Physikern möglich sein. Ein Chemiker Dr. WOLF äusserte mir kürzlich die Ansicht, dass

der primäre Effekt wohl nicht die Adsorption von Lipoiden wäre, sondern die Störung einer äusserst dünnen, vielleicht nur 1 Mol. dicken Wasserschicht, die aussen an der Epicuticula anhaftet.

Schliesslich wäre noch einiges über Zusammenwirken von Aktivpulvern und Kontaktinsektizide zu sagen. Hierfür tritt u.a. auch GAY (1944) ein. Er glaubt, dass die Kombination von Magnesit und DDT eine Steigerung der Wirkung ergeben müsste. Ich bin auf diese Frage schon in Stockholm eingegangen und habe dort gesagt, dass erstaunlicherweise keine Addition der Wirkung eintritt, sondern dass Schiefermehl und solches mit 5% DDT keine unterschiedliche Wirkung ergaben. Weitere Versuche sind in Tabelle II wiedergegeben.

Tabelle II

Aktiv Pulver	rein	mit 1% DDT in Azeton	mit Azeton
Talkum	77,7% L.D.	22,2% L.D.	72,7% L.D.
Talksteinmehl	42,8	50	50
SiO_2 (Cohasit)	22,2	33,3	27,7
,, (Kieselgel)	27,7	22,2	22,2
MgO	38,7	27,7	27,7
Aktivkohle	37,7	27,7	27,3
Zuckerkohle	33,3	38,7	33,3

Eine wesentliche Verkürzung der Lebensdauer ist also nur bei Talkum und MgO erfolgt, während bei den anderen Pulvern die Lebensdauer durch die Zufügung von DDT wenig oder garnicht beeinflusst wurde. Trotzdem sollte man die Hoffnung nicht aufgeben und weiter nach geeigneten Kombinationen suchen.

Es wäre gut Normen für die Wertbestimmung aufzustellen, etwa in folgender Weise:

1. Abtötungsgeschwindigkeit abhängig von
   a) Teilchengrösse
   b) Adsorptionskraft
   c) Temperatur
   d) rel. Luftfeuchtigkeit
   e) Menge
   f) vielleicht von der elektrischen Leitfähigkeit.

2. Initialtoxizität
3. Preis
4. Silikosegefahr
5. Beeinflussung der Marktqualität des behandelten Produktes.

Ich habe immer gewünscht, dass die chemische Industrie in Deutschland dieser Frage mehr Interesse entgegenbringt. Die englische Industrie hat bereits hervorragend wirksame Pulver auf den Markt gebracht, von denen z.B. GAY die Aluminiumpräparate „Alumicide" und „Alkalox" und das Kieselsäurepräparat „Neosyl" hervorhebt. Ich glaube, dass bei intensiver Zusammenarbeit der Chemischen Industrie und der Wissenschaft hier noch wichtige Fortschritte zu erzielen sind.

DISCUSSION

Mrs. **Wolfram**: gibt die folgende Erklärung für die Zurückhaltung der Industrie auf dem Gebiet der insektiziden Stäube: es gab bis zum Kriegsende in Deutschland ein gesetzliches Verbot jeglicher Zumischung von anorganischer oder organischer Substanzen zu Lebensmitteln, dessen Wiederaufleben vor der Tür steht.

Mr. **Zacher**: Dieses Gesetz würde aber gleichfalls die Kontaktinsektizide betreffen.

Mrs. **Wolfram**: Auch die sind von der Industrie nicht primär für die Getreidebehandlung geschaffen worden.

Mr. **Besemer**: Ist etwas bekannt von Silikose Gefahr oder andere Erscheinungen solcher Art bei Aluminiumoxyde Präparate?

Mr. **Zacher**: Hiervon ist nichts bekannt.

Mr. **Sy**: Stellen die Teilchengrössen von 1-15 μ das Wirkungsmaximum dar in Bezug auf grössere Teilchen oder auch im Bezug auf noch feinere Teilchen? Liegen Untersuchungen über Pulver mit Teilchen unter 1 μ dar?

Mr. **Zacher**: Ja, unter 1 μ ist die Wirkung geringer.

Mrs. **Wolfram**: Gibt es in der Praxis heute noch Vorkommen von reinem Kornkäferbefall, der eine Umwaltung mit insektiziden Stäuben rechtfertigte?

Mr. **Zacher**: Nur auf Bauernspeichern.

Miss **Petrik**: Ich interessiere mich für die praktische Seite der Anwendung oberflächenaktiver Stoffe. Wie steht es mit der Reinigung des Futtergetreides? Ist das für grossen Mengen des Getreides verwendbar?

Mr. **Zacher**: Jede Gross-Mühle hat ausreichende Reinigungsapparate.

Mr. **Keiding**: In Denmark „Kieselguhr" at a rate of 0.5% was used much during the war to control grain weevil with good results, provided the humidity not being too high. It is amazing that you get so good an effect at high humidity. Since the war "Kieselguhr" has been replaced by DDT dusts, among other things for the following reasons: 1. Good effect even at high humidities, 2. more rapid effect, 3. less material is needed, e.g. 0.1%, so the grain is not so contaminated and the application is easier.

Mr. **Zacher**: Es ist sicher, dass die oberflächenaktiven Pulver die grösste Anwendungsmöglichkeiten in trocken- heissen Klimate haben werden. So werden z.B. in Ägypten Phosphate in grossen Umfang gebraucht.

INSECTICIDE PROBLEMS IN THE UNITED STATES OF AMERICA

by

F.C. BISHOPP

Washington D.C., U.S.A.

The development of numerous insecticides since the discovery of DDT has given entomologists excellent weapons with which to combat insect pests, but has presented many new and serious problems.

It has been estimated that in the United States of America alone there is being produced annually about 250,000,000 pounds of technical insecticides exclusive of sulfur. Great benefits have accrued from the use of these materials in the protection of forests, livestock, crops and man himself.

Under the intensive research program conducted by Federal and State agencies and industry many of the limitations of the various insecticidal chemicals have been determined but much remains to be learned about them. Some of these limitations such as effectiveness against numerous pests, compatibility with other pesticides, difficulties of formulating, and adverse affects on plants or animals are quickly recognized, but other effects such as disturbance of the biological balance, soil contamination, and chronic toxicity to animals require long-time and extensive tests to become evident.

The successful use of DDT in the control of lice, flies, mosquitoes and fleas during the second world war caused many people to feel that it was a panacea for all insect troubles. That idea and the appearance of other effective insecticides led most everyone to depend almost entirely on insecticides and to neglect other well recognized control methods.

Problems of Toxicity of Insecticides to Higher Animals

The rapid development and recent use of new insecticides precipitated some of the problems. A serious one of these is the question of hazards to the user and to the public. The existance of hazards was apparent to various agencies and industry and recommendations have been drawn with a view to safeguarding all public interests.

The need for establishing safe limits or tolerances of residues of pesticides on foods was recognized by the Food and Drug Administration when on September 17, 1949, notice of a hearing was issued primarily to fix insecticide tolerances on fresh fruits and vegetables. During an eight-month period 255 witnesses appeared, and their testimony covered 9195 written pages. Although the evidence is being studied, it may be several months before the findings are announced.

Although the probable total intake by man of an insecticide is being considered in fixing tolerances, it appears that with the use of proper dosages, number of applications, types of formulations, and proper timing, reasonable tolerance levels can be met and good insect control obtained. The rapidity

and extent of absorption and storage in the fat and excretion in the milk of animals treated with some of the chlorinated insecticides especially DDT, TDE, and lindane is a matter of concern. This is also true when animals are given feed bearing residues of these materials. Entomologists are recommending compounds such as methoxychlor which have a lower chronic toxicity and are less prone to appear in the fat or milk. Instructions are also issued to stockmen not to feed materials bearing residues of DDT and certain other insecticides to animals being finished for slaughter.

Since public anxiety has arisen over exaggerated stories of people being killed or made ill by the new insecticides, a Congressional Committee was set up to investigate the whole question of food additives and recommend legislation. The Department of Agriculture witnesses recommended that pesticides be considered in a different category than food additives. Interest in the toxicology of pesticides is indicated by the fact that at least nine committees are giving consideration to various aspects of this field.

A number of deaths during the past two years have resulted from the careless handling of parathion, hexaethyltetraphosphate and chlordane. The cases involving chlordane were due to excessive skin exposure to the concentrated material, usually by breaking bottles or spilling it on the clothing and failure to remove it promptly. The deaths from the phosphates were associated with exposure of operators for a considerable period in hot weather and usually after warning symptoms were ignored. A considerable number of illnesses have been accredited to both parathion and hexaethyltetraphosphate among operators and persons in the immediate vicinity of extensive aerial applications.

In general, entomologists have recommended the use of these highly toxic materials only by men who fully understood the dangers and were ready to assume full responsibility for enforcing all precautionary measures. Cautions are carried in all government publications recommending any hazardous insecticide for public use and the labels on containers also carry full precautionary information and antidotes.

The Insecticide Division, Production and Marketing Administration, Department of Agriculture, has been confronted with many problems in its registration of pesticides under the Insecticide, Fungicide and Rodenticide Act but these difficulties are being met with reasonable satisfaction to industry and with assurance of good public protection.

Aside from hazards to users and the public, protection of fish and wildlife is an important consideration. Most of the newer insecticides are highly destructive to fish, amphibians and reptiles and they must be used with circumspection around ponds, lakes, and waterways. Toxaphene, which is extensively used for the control of cotton insects, is particularly destructive to fish.

Effect on Plants of Insecticides in the Soil.

The possibility that heavy and continued applications of the more persis-

tent insecticides such as DDT may render soils unsuitable for growing susceptible crops must be recognized. No serious difficulty of this kind has been encountered, but experimental work carried out largely by the Bureau of Plant Industry, Soils and Agricultural Engineering has shown that this is a real danger. Plants such as rye, certain cucurbits and some legumes grown on light sandy soils low in humus are likely to show injury when 25 pounds of technical DDT are applied to the soil.

Farmers are anxious to reduce the cost of operations by applying soil-insecticides in fertilizers. The wide range in the amount of fertilizer used per acre is likely to result in an over dose in some instances and an ineffective one in others if mixtures of the same proportions are used by all. Mixing the materials to meet specifications of different farmers appears to be the answer.

Off-flavor in crops treated with benzene hexachloride or lindane or grown in soils treated with those materials has been another problem. Potatoes, various root crops, and peanuts grown in such soils are often rendered inedible. Chlordane appears also to cause off-flavor in peanuts when grown in soil treated with that material.

The possibility of benzene hexachloride applied to one crop such as cotton persisting in the soil long enough to cause off-flavor in peanuts and root crops the following year is being investigated.

Toxaphene has been found to be effective for the control of hornworms, grasshoppers, cutworms, and the suckfly on tobacco. Under some conditions toxaphene, which is effective in the control of several tobacco pests, may have an objectionable effect on the odor of the cured tobacco.

A somewhat related problem being studied by the Bureaus of Dairy Industry and Entomology and Plant Quarantine is to determine the extent to which lindane may be used on or fed to dairy cattle without tainting the milk.

Crops Susceptible to Insecticides.

Many tests have demonstrated that DDT, particularly in its cruder forms, injures some varieties of squash and cucumber although the same dilutions did not injure related plants such as pumpkin, watermelon, or cantaloup.

DDT sprays or dusts stunted the growth of the Triumph variety of lima bean and reduced its yield, but did not have any ill effect on 13 other varieties of lima beans.

The Effect of Insecticides on Beneficial Insects.

Insecticides that are effective against many species are likely to affect adversely insect pollinators, parasites, and predators. In the United States we are particularly concerned about the effect on honey bees of the wide scale use of various insecticides and herbicides. Measured dosages and timing of applications of insecticides becomes necessary if bees are to be protected.

Spraying orchards in which cover crops beneath the trees are in bloom

has had a disasterous effect on bees. Mowing the crop before spraying is often practical.

Dieldrin, parathion, lindane, aldrin, and chlordane are considered dangerous to honey bees when applied to alfalfa in bloom. DDT can be used at effective strengths at the risk of killing field bees but does not destroy the entire colony. Toxaphene, at 1½ pounds per acre, is the least harmful. Arsenical insecticides are the Number 1 killers since the whole colony may be destroyed.

The absence of parasites and predators due to their destruction by insecticides, appears to be the explanation of many instances of pest increases. For example the use of DDT to combat dipterous leaf miners (*Liriomyza* spp) on lettuce, cantaloup, and other vegetables in Arizona has been shown to result in the death of so many of the leaf miner parasites as to cause an outbreak of these miners. Spraying citrus trees several times with DDT for the control of the citrus blackfly (*Aleurocanthus woglumi* Ashby) has often resulted in a heavy buildup of red scale (*Aonidiella aurantii* Mask).

Increasing Other Pest Species.

The destruction of parasites and predators doubtless has much to do with the appearance of other pest problems even though the major pest is kept under control. For example, there is the well known instance of cotton aphid (*Aphis gossypii* Glov.) outbreaks following applications of calcium arsenate for boll weevil control and the appearance of spider mites (*Tetranychus* spp), on various crops and trees especially after heavy treatments of DDT.

As recently as 1944 apple growers throughout the United States were lamenting the fact that the codling moth was about to put them out of business; other insects and mites were of comparatively little concern. Today, 1951, the codling moth has been reduced by the use of DDT to a pest of minor importance but a number of other insects and mites have become problems.

These new problems are being met, at least temporarily, by using other insecticides or acaricides and often mixtures of two or more of these.

Insect Resistance to Insecticides.

The development of strains of insects resistant to insecticides is one of the most serious and disheartening problems confronting the entomologist.

This is not a new phenomenon, but it has been brought more forcefully to the fore in the last four years. As early as 1908 resistance was reported of the San Jose scale (*Aspidiotus perniciosus* Comst.) to lime sulphur, and there are many subsequent cases.

Although the effectiveness of DDT against the house fly was outstanding for several years, scientists in various parts of the world began to find flies resistant to this insecticide. When it was discovered that house flies could develop such a high resistance that they could live in constant contact with DDT, and that they could build up a resistance to almost any insecticide, the situation looked hopeless.

Investigations are going forward to try to find synergists for DDT and other fly killing materials and ways of breaking down the resistance mechanism of the insect. The solution of this problem, it seems to me, lies in two directions (1) to find out definitely the mode of action of DDT and other chemicals on insects and how their defense is built up and (2) to develop against resistant pests other lines of attack including sanitation, and the use of natural, mechanical, cultural and sanitary measures.

There is every reason to believe that other pests will develop some degree of resistance to insecticides. In fact a number of instances of this have already come to light. A notable example is the case of the two-spotted spider mite (*Tetranychus bimaculatus* Harvey) becoming resistant to parathion, in the form of an aerosol.

Equipment Problems.

The development of new highly effective insecticides has made necessary revolutionary changes in equipment for applying them. To conserve materials, reduce residue and other hazards, and save manpower, means of applying with reasonable accuracy and uniformity, quantities of insecticides as small as two quarts to one gallon per acre had to be devised. To meet this need there are being manufactured blower sprayers depending on high velocity air to breakup and carry the insecticide, and aerosol machines, utilizing liquified gas, steam, combustion gases or high speed revolving discs to produce the fog.

Aircraft have been fitted with various spray devices involving engine exhaust to disperse a fog, or spray booms with appropriately spaced nozzles and pumps to deliver a fine spray.

Scarcity of Materials.

Under the present intense effort to increase food, feed and fiber as well as to protect people, livestock, and forests the demand for pesticides is heavy. Basic materials such as alcohol, chlorine and benzene needed in insecticide manufacture are also required for other defense purposes. This leads to keen competition and presents troublesome problems of production and distribution of such materials. Difficulties with reference to containers and shipping facilities are also considerable. Sulfur, previously abundant and cheap, is now in critically short supply, and other dependable insecticides are not always readily available. Entomologists in the United States are therefore confronted with the problem of discovering alternative materials for nearly every insecticide so that demand for effective means of combating our several hundred insect pests can be met promptly under any circumstance.

DISCUSSION

Mr **Stapley**: Dr. BISHOPP in his paper weighed the balances heavily against the new synthetic insecticides. I should like to suggest that these insecticides have given control of insectpests which formerly were not controllable. For example in England we can now control wireworm with BHC. Overseas locusts and the wheat leaf miner (*Syringopais*) can be cheaply and safely controlled with BHC. Likewise we can control apple blossom weevil (*Anthonomus*) with DDT and foliage feeding mites with parathion. Parathion has also given control of the Middle East wheat pest "Sunni" (*Eurygaster*). By using DDT for the apple blossom weevil in England for many years this insect has been almost eliminated. Recently BHC has been used for control of apple sawfly (*Hoplocampa*) of which it gives about 100% control. It is hoped that virtual elimination of this insect will follow continued use of BHC.

Mr. **Zacher**: Are there cases of poisoning from DDT in the USA?

Mr. **Bishopp**: There have been no authentic cases of poisoning of men from DDT and related compounds when used as insecticides. Some cases of illness have been reported through accidental or purposeful ingestion of chlorinated hydrocarbon insecticides and those ill effects may have been due to the solvent used.

Mr. **Thomas**: Would Dr. BISHOPP please tell us what are the precautions taken in the U.S.A. to prevent contamination of milk with DDT?

Mr. **Bishopp**: The use of DDT in dairy barns and on dairy animals is advised against and this advise is being generally followed. DDT and other chlorinated hydrocarbon insecticides that are likely to appear in milk when treated crops are fed, are not recommended for use on any crop that is to be fed to dairy animals in production. The use of such insecticides in milkhouses and other dairy plants is also advised against. Analysis of milk in commercial channels has shown that there is very little or no contamination taking place.

Mr. **Hogan**: Have toxic hazards of some of the new insecticides affected the trend towards labor-saving by insectide-machinery of air blast type?

Mr. **Bishopp**: Yes. Reduction of hazards has not been the only factor encouraging the use of air blast type sprayers, but it is an important one. The use of air blast machines has reduced the quantities of sprays necessary and this materials are conserved and hazards from residues and soil contamination are minimized.

Mr. **Blunck**: I would be glad to hear if there have been already any serious accidents by consumption of poisoned milk in the States.

Mr. **Bishopp**: Only very low levels of insecticides have been found at any time in milk and steps to avoid milk contamination are purely a precautionary measure. There have been not cases of ill effects on men resulting from ingesting milk or any other food except the few recorded cases where DDT was accidentally put into food by mistake.

Mr. **Stapley** remarks that the paper gave a rather dark picture of the insecticide situation.

Mr. **Bishopp**: I recognize that my paper presented a dark picture but you must remember that my subject was on "problems in the insecticide field" and there was not time to deal with the tremendous advantages in improved production and bettered health that have resulted from the use of pesticides in the United States. Crops have been protected from destruction by many pests and their quality has been improved; forests of hundreds of thousand of acres have been saved from devestation; livestock has been protected from insect annoyance and dairy and beef production materially increased; people have been relieved from insect attack and diseases that are carried by these pests and yields of fibre crops have been greatly increased. These striking benefits and many others have come about through insecticide use. Yet we must not overlook the difficulties and be prepared to meet them.

VAPORIZATION OF INSECTICIDES

by
Harvey L. SWEETMAN and Philip J. SPEAR
Amherst, Mass., U.S.A.

Vaporization, one of the older methods for dispersing insecticides, has been little used because the apparatuses for the purpose have been cumbersome and poorly controlled. With the development of efficient and accurately controlled heating devices the advantages of vaporization may now be utilized. This paper is a preliminary report of investigations of vaporized insecticides, currently being conducted at the University of Massachusetts, and certain general considerations which have been derived from this study.

History

GNADINGER (1946) considers that one of the earliest uses of pyrethrum was placing the powdered flowers on a hot stove to volatilize the active portion. Aerosols of rotenone were made by burning rotenone-bearing roots (FREAR, 1942). BOURCART (1913) describes the evaporation of nicotine in enclosed areas by placing tobacco, or its juices on hot surfaces. FERNALD (1926) noted that nicotine could be vaporized from a dish over a lamp or by burning impregnated papers. One fluid ounce per 1000 cubic feet was suggested as the dosage to be used in tightly closed rooms against such greenhouse insect pests as aphids. Between 1920 and 1940 naphtalene was widely used for greenhouse fumigation for control of Greenhouse Red Spider, *Tetranychus telarius* Linn. (HARTZELL, 1926; WHITCOMB, 1935). These methods consisted of placing crystalline naphtalene in a variety of containers over heat sources to produce a concentration of naphtalene vapor for limited periods of time WHITCOMB (1935) heated the insecticide in increments placed hourly upon the apparatus for 6 hours and recommended concentrations of 2 to 3 ounces of naphthalene per 1000 cubic feet. Such treatments are of relatively short duration and the maintenance of insecticidal concentrations in a greenhouse for as long as 42 hours (HARTZELL, 1926) is the longest application by vaporization noted in the literature. Paradichloro-benzene, however, which is widely sold for wool-pest control, is dispersed by vaporization and when properly used maintains insecticidal concentrations for extended periods of time. Such concentrations are possible because P.D.B. has a relatively high vapor pressure and is evolved readily at ordinary room temperatures.

SULLIVAN (1951) has described a method of vaporizing lindane into enclosures from Fiberglas filters which are coated with the insecticide and then placed in the air flow from a household fan. It appears that this method is intended to be used intermittently. Other insecticides having lower vapor pressures may be evaporated into enclosures by passing larger volumes of air over them or by heating them. The vaporization of lindane by heat may

be sustained at rates of 0.4 to 15 micrograms per hour per cubic foot giving concentrations which are toxic to many insects without being objectionable to humans (CHRISTOPHER & SPEAR, 1951). Under suitable conditions insecticidal concentrations may be maintained for extended periods of time in public rooms such as stores and restaurants. Under such conditions the enclosure in subject to continuous space treatment which can be maintained for very long periods of time such as a fly season, as lethal concentrations of insecticide will always be present to affect those insects which may be newly emerged or newly arrived in the area being treated. Some preliminary results from studies with sustained concentrations of DDT to man and animals (STAMMER & WHITFIELD, 1947) and similar use of insecticides in greenhouses (FOX-WILSON, 1949) have been reported.

Description of vaporizer.

The equipment we have used for vaporization of insecticides is a commercial device, the "*Aerovap*" *) (Fig. 1) which utilizes controlled heat to cause vaporization. It consists of an outer bowl attached to a wall bracket, an intermediate receptacle having heating elements and thermostat and an inner cup containing the insecticide (Fig. 2). Heat is produced by a resist-

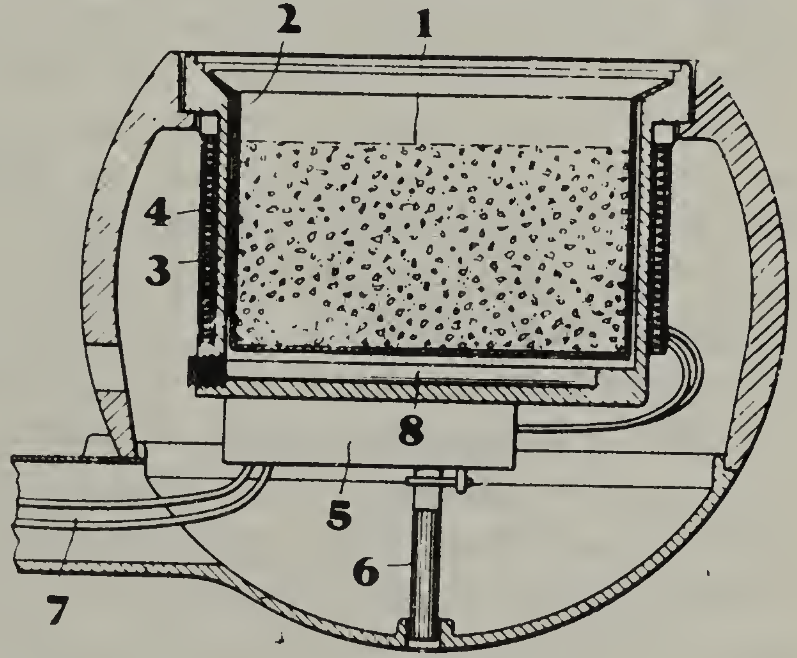

Fig. 1. The "Aerovap" ready to be installed. Fig.2. A cross-section of the Aerovap.

The insecticide (1) is placed in the inner cup (2) which is supported from its flared rim in a cast metal intermediate receptacle (3). Electrical heating coils (4) are controlled by the thermostat (5) which is adjusted by a screw (6). Electricity reaches the unit through wires (7). Temperature readings are taken by inserting a thermometer through the housing via the hole at the left and into the well or channel (8).

ance-type heating element from 110 or 220 volt AC or DC current. The thermostat is adjustable and accurate so that the rate of evaporation may be closely controlled. Production models have a heating range from room

*) Product of American Aerovap, Inc., New York, N.Y.

temperature to 200° C and experimental models permit use up to 250° C. The unit is provided with a thermometer well for temperature readings (Underwriters' Laboratories, Inc., 1947). The insecticide cup has a capacity of approximately 250 cc. and will hold 100 to 400 grams of insecticide depending upon its density.

Evaporation process and resulting insecticide dispersions.

When a solid substance is heated, the kinetic energy of each molecule increases. As the molecules become more mobile the solid expands and if further heated becomes liquid and finally gaseous. Throughout this process molecules of the material escape at a rate proportional to the heat applied. With some insecticides such as lindane adequate concentrations for insect control are achieved without heating the crystalline material to the melting point. With other insecticides such as the DDT group greater heat is required and liquefaction occurs long before insecticidal concentrations are achieved in air. At any rate, the substance heated passes off in the gaseous state. Now the molecules of a gas are widely separated beyond the range of their mutually attractive forces and separate at once on collision because of their kinetic energy. Gases lack cohesion and tend to spread uniformly (GIBBS, 1924). With insecticides having low vapor pressures, the vapor condenses immediately above the heating unit forming an aerosol in which the dispersed phase is pure insecticide. It rapidly diffuses throughout the air in the enclosure and its existence may be determined visually by the Tyndall effect or experimentally by mortalities of suitably exposed test insects. While the most important factor effecting the rate of evaporation is the amount of heat applied, it is apparent that the surface exposed and the rate of air flow over the surface will also affect vaporization rates.

Rates of evaporation for four insecticides when heated are shown in Fig. 3. These are smoothed curves of data obtained using the Aerovap previously described. The well temperatures shown are recorded on the underside of the aluminium cup containing the insecticide. Depending on the physical state of the heated insecticide its surface temperature may be 5 to 35° C. less than the well temperature. It may be seen that lindane (the gamma isomer of benzene hexachloride of a purity of at least 99%) has a much higher vapor pressure than does DDT since at 120° about 5 times as much lindane is evolved as DDT. The difference in vapor pressure also affects the physical nature of the dispersed insecticide. Where used under ordinary conditions for control of flying insects, as at 1 gram of insecticide per 20.000 cubic feet per day, our observations indicate that lindane always remains as a gas. As such it is quickly and widely distributed. On the other hand, DDT with a much lower vapor pressure quickly saturates air into which it is evaporated and condenses into droplets which consist initially of pure liquid DDT. These droplets, when deposited on glass plates, have particle sizes ranging from the limits of resolution of the microscope to about 12 microns in diameter and remain liquid about 4 days.

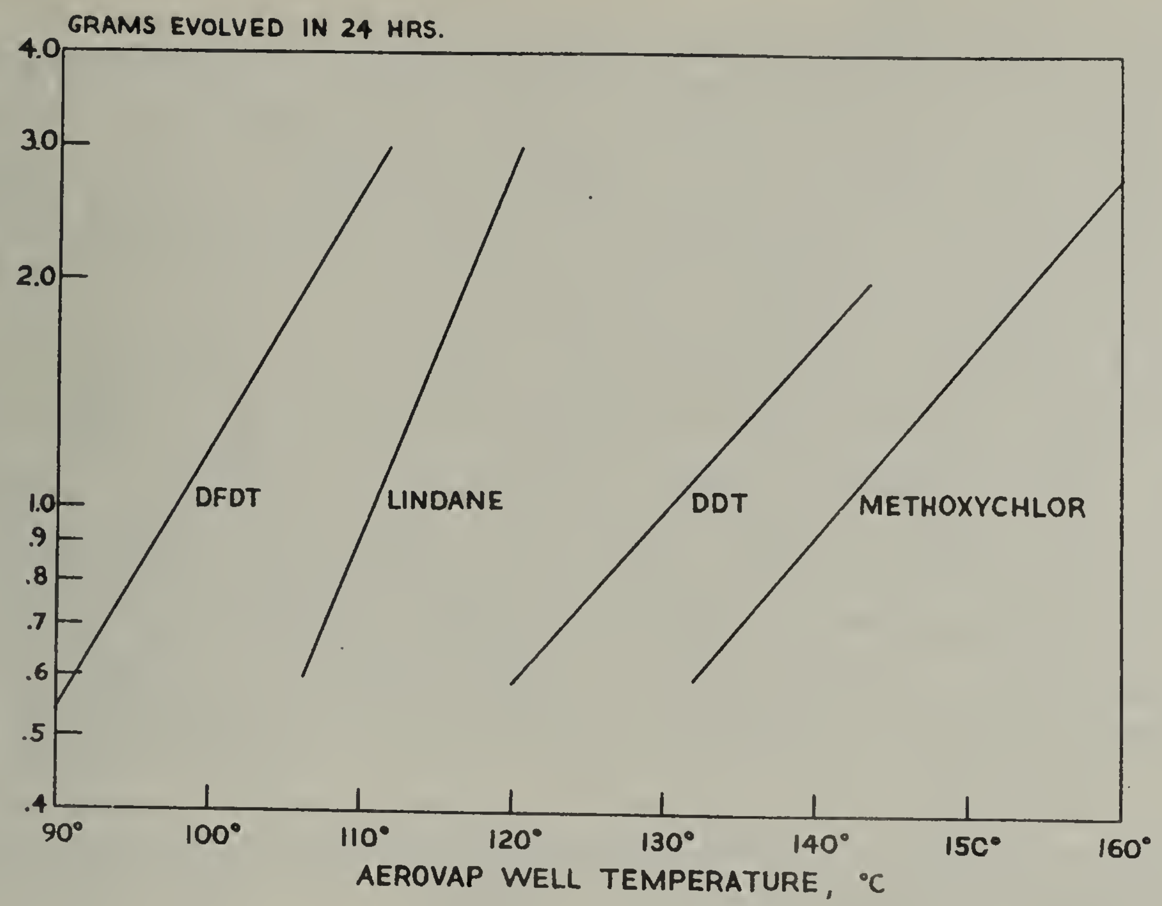

Fig. 3. Approximate Vaporization rates of DFDT, Lindane, DDT and Methoxychlor from 8 cm. cup in "American Aerovap".

Choice of vaporization as a method.

Having discussed equipment for vaporizing insecticides and some of the problems and properties of insecticides when vaporized, we can now consider some of the factors which may influence our selection of vaporization as a method of insecticide dispersal as compared to other methods. It is obvious that the utility of this method is limited to enclosures. But many enclosures require frequent insecticidal treatments for such pests as houseflies, fruit flies, sand flies, mosquitoes, food infesting moths, silverfish, spiders and certain ecto-parasites and plant feeders. We have carried on experimental work in stores, markets, homes, dormitories, a variety of poultry and animal shelters, warehouses and greenhouses. In many of these or similar structures vaporization seems to be the preferred method of insecticide dispersion where the pests to be combatted spend at least part of their life cycle in the open. The insecticide is continuously dispersed so that there need be no interruption of normal activities as is commonly the case with spray or dust applications. Because the amounts of insecticide employed are so small vaporization does not require covering of fixtures before installation of removal of residues, or stains which frequently occur with other methods. Where livestock are being protected from insect pests this silent, motionless method of dispersal is obviously preferable to conventional methods. Likewise where economy of labor is of importance it should be realized that a vaporizer can be installed in 15 to 20 minutes and thereafter requires but occasional adjustment, inspection and replenishment of insecticide. On the other hand special skill is required on the part of the person placing the device.

Choice of an insecticide

Choice of an insecticide to be vaporized for any particular purpose requires consideration of many factors. Some of the questions to be answered are: Which insecticide will most effectively combat the pests in question? How best can the pest be reached? Are plants or other objects in the area likely to be adversely affected? Are deposits of insecticides likely to occur so as to be dangerous to humans or other animals?

As mentioned above, insecticides which are to be successfully vaporized by heat must be pure so that evaporation rates will be constant, and must be stable in the temperature ranges required for evaporation of insecticidal concentrations. Many common insecticides meet these requirements. All principal members of the DDT group of insecticides may be vaporized. DDT was widely used before the advent of DDT-resistant flies and is still useful against many pests. DFDT vaporizes readily with less heat than is required for DDT, but lack of commercial production in the United States and inadequate knowledge of its mammalian toxicity makes commercial usage impractical at this time. TDE and Methoxychlor may have special applications where high margins of safety are required.

At this time lindane appears to be the most suitable and most widely used insecticide in vaporizing devices for control of structural pests. Its relatively high vapor pressure and rapid insecticidal activity have combined to give excellent results in both laboratory and commercial practice. Several other insecticides appear capable of vaporization but have not as yet been manufactured in the pure state in adequate quantities. The insecticidally active compounds in chlordane, dieldrin or aldrin might be included in this last group.

Toxicity

If insecticides are to be continuously dispersed in areas where humans, pets or their food are present, it is apparent that the problems relating to toxicity of higher animals must be well understood. In investigating these problems we have exposed several species of animal life in concentrations of insecticide suitable for commercial use as well as to massive doses. Ten rats have now been exposed continuously for more than a year to very high concentrations of lindane vapor without showing any apparent departure from condition or behaviour of similar rats not so exposed. Chemical and histopathological studies of tissues of rats exposed 7 months in these extreme conditions revealed neither the presence of lindane nor damage attributable to it. Exposure to lindane concentrations in excess of those required for satisfactory insect control did not cause any apparent damage or distress to very young rats, chickens or pigeons. Data from these studies and from exposure of poultry and ornamental fish will be published elsewhere.

FITZHUGH et al. (1950) have reported that 800 p.p.m. of gamma benzene hexachloride in the lifetime diet affects neither growth nor mortality rates of rats and no tissue damage occurs with doses of 50 p.p.m. Lindane is not

found in the body of rats fed less than 50 p.p.m. in their diet and lindane deposited in rat tissue by higher levels of feeding rapidly disappears (LEHMAN, 1950). These results with ingested lindane together with our long-term exposures of rats to high concentrations of lindane vapor indicate that the continuous exposure of humans to concentrations of insecticidal value against flies, mosquitoes and the like is not hazardous. On the other hand, it has been determined that several species of ornamental fish are susceptible to lindane at normal concentrations. Apparently, the insecticide is dissolved in the aquaria water in sufficient amounts to reach the 1 p.p.m. concentration stated by SLADE (1945) to be fatal to such fish. Canaries are susceptible to high concentrations and probably should not be exposed to commercial concentrations although repeated recoveries have been noted when the ill canary was removed from the exposure room. The effect of the vapor of other insecticides has not been determined on fish or canaries.

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DISCUSSION

Mr. **Hopf**: Has the speaker any comparative data on the hazards of crude BHC with lindane, given by this method?

Mr. **Sweetman**: BHC has not been tested extensively because of ill flavors produced in foods, poultry, eggs, milk etc.

Mr. **Goodwin-Bailey**: Can Dr. SWEETMAN say how many air changes can

take place in a given unit of space before the aerosol losses efficiency. Normal domestic and warehouse premises usually have several changes of air per hour.

Mr. **Sweetman**: Extremely rapid change of air renders the application ineffective. However barns and poultry shelters were successfully treated for houseflies, hornflies and poultry lice.

Mr. **Park in**: Has Dr. SWEETMAN any experience in the use of this method of application of DDT and lindane in warehouses for control of stored products insects?

Mr. **Sweetman**: Yes, lindane has been quite successful against stored food moths and beetles in general. DDT has been effective in prevention and eradication of woolpests in warehouses, primarily against the adults.

Mr. **Jary**: Has the use of continuous DDT in the aerovap shown any toxicity to cats?

Mr. **Sweetman**: No cats have been sufficiently exposed in the experiments here quoted for conclusive data to be obtained. It seems unlikely that there would be any toxic hazard.

Mr. **Madwar**: Has this method of application been used in steamships or airplanes?

Mr. **Sweetman**: Some experiments were made in Great Britain and the U.S.A. The results are not yet definitieve, but there seems to be some prospects for using this method.

Mr. **Cameron**: Is there any danger of the production of insectpests resistant to the insecticides applied by this method?

Mr. **Sweetman**: There is no firm evidence of this.

UNTERSUCHUNGEN ÜBER SELEKTIVE INSEKTIZIDE MIT TIEFENWIRKUNG

von

R. GASSER

Basel, Schweiz

Im Rahmen der Arbeiten über Insektizide in den von Herrn Dr. HENTRICH leiteten Forschungslaboratorien der J.R.Geigy A.G. kam eine Gruppe neuiger *Urethane* zur Bearbeitung, welche für die Schädlingsbekämpfung inessante Möglichkeiten zu erschliessen scheint. Von den zahlreichen Verıdungen konnten bisher zwei in grösserem Umfang biologisch geprüft wern, sodass wir uns in den folgenden Ausführungen auf diese beschränken. handelt sich um: 5,5-Dimethyldihydroresorcin-dimethylcarbamat *) „*Dimen*" und 1-Phenyl-3-methyl-pyrazolyl-(5) dimethylcarbamat *) „*Pyrolan*".

ysikalische Eigenschaften: Das „Dimetan" besteht aus farblosen Krislen mit einem Schmelzpunkt von 45-46° C. Neben einer guten bis mäsgen Löslichkeit in organischen Lösungsmitteln zeigt es auch eine Wasrlöslichkeit bis zu 3,15% bei 20° C.

Bei dem farblos-kristallinen „Pyrolan" liegt der Schmelzpunkt bei 50° C. ist in den meisten organischen Lösungsmitteln löslich, in Wasser von ° C. bis zu 0,1%.

xizität: Nach den bisherigen Untersuchungen **) beträgt die DL 50 per bei „Dimetan" für Mäuse 90 mg/kg, für Ratten 150 mg/kg, bei „Pyrolan" , resp. 90 mg/kg. Die perkutane Resorption beider Substanzen ist gering.

sektizide Wirkung: Diese kann je nach Insektenart und Konzentration sohl durch Frass wie durch Kontakt zustande kommen, wobei beide Subınzen eine ähnliche Selektivität aufweisen, die allerdings bei „Dimetan" ch etwas ausgesprochener ist.

In den Frassversuchen ertragen Lepidopterenraupen, Blattiden und Copteren im täglichen Futter bis 20 mg (entspricht ca. 2-5 g/kg Körperwicht) ohne Schaden. Während das „Dimetan" zum grössten Teil unverut mit dem Kot abgeht, kann das „Pyrolan" im Kot nicht nachgewiesen rden und muss deshalb im Körper gespeichert oder abgebaut werden.

Gewisse andere Insekten dagegen können mit diesen Substanzen per os rgiftet werden, wie die Tabelle zeigt.

Die Unterschiede zwischen „Dimetan" und „Pyrolan" in der Giftwirkung f die einzelnen Insekten sind sehr gering; auffallend dagegen sind die

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*) Die Synthese dieser Substanzen wurden von Herrn Dr. H.GYSIN ausgeführt.

**) Die toxikologischen Angaben wurden mir durch Herrn Prof.Dr.DOMENJOZ zur Verfügung gestellt.

kleinen Dosen, die zum Abtöten der schwarzen Ampferblattlaus, der Mehl motte und der Stubenfliege genügen gegenüber den verhältnismässig grosse Dosen, die für die Biene und die Gamma-Eule benötigt werden. Der Vergleic mit dem sehr unspezifisch wirksamen Parathion lässt diese Selektivität noc deutlicher hervortreten.

In den Kontaktversuchen zeigen beide Präparate in hohen Konzentratione ein ziemlich breites Wirkungsspektrum mit sehr rascher Wirkung. Niedrig Konzentrationen dagegen erfassen nur noch wenige Versuchstiere, vor aller Aphiden, Fliegen und auch *Bryobia praetiosa* Koch.

In entsprechenden Temperaturversuchen konnte einerseits nachgewiese werden, dass die Wirkung dieser Substanzen mit sinkender Temperatur zu rückgeht und andererseits, dass „Dimetan" temperaturabhängiger ist al „Pyrolan".

Die Insektizid-Versuche zeigen also, dass diese Substanzen einerseit erfolgreich in Fliegensprays verwendet werden können und sich anderseit im Pflanzenschutz vor allem zur Bekämpfung der Aphiden eignen.

Verlauf der Vergiftung: Die Vergiftungserscheinungen, die von „Dimetan und „Pyrolan" bei den Insekten verursacht werden, decken sich nach de Untersuchungen von WIESMANN weitgehend und sind sehr charakteristisc

Je nach Aufnahme und Empfindlichkeit dauert es verschieden lange, bi die Insekten eine schwache Erregung zeigen. Durch Beinlähmungen und Ko ordinationsstörungen wird das normale Gehen bald unmöglich. Ganz unve mittelt fallen sie auf den Rücken und zeigen einen Beintremor, den man al klonischen Tetanus oder Strecktremor bezeichnen kann. Die Beine werde dabei unter starkem Zittern für 3-5 Sekunden vollständig gestreckt und e starren. Zwischen den einzelnen Tetanuszuständen sind die Extremitäte völlig entspannt und bewegungslos und reagieren nicht auf taktile Reize Der Strecktremor wird in der ersten Zeit 5-6 mal pro Minute ausgeführt, dan klingt er nach und nach ab und die Intervalle zwischen den einzelnen Tetanus phasen werden länger bis nach einiger Zeit, je nach Empfindlichkeit der In sekten und Giftgabe entweder Tod oder Erholung eintritt.

Schon zu Beginn der Vergiftung führen die Mundwerkzeuge und der Oeso phagus rasche Bewegungen aus. Die Tiere schlucken dadurch Luft und blä hen sich oft derart auf, dass die Abdominalsegmente und Intersegmentalhäut maximal auseinander getrieben werden. Während des Tremors der Extremi täten setzen die Mundbewegungen kurz aus.

Wirkungsmechanismus: Er scheint für beide Substanzen identisch zu sei und wurde von WIESMANN vor allem an *Blatta americana* L. eingehend stu diert. Entsprechende Versuche zeigten, dass den Thoracalganglien entsche dende Bedeutung bei der Auslösung des klonischen Strecktremors der Extre mitäten zukommt. Diese ist nur möglich beim Vorhandensein eines unve letzten Reflexbogens. Beim Durchschneiden der Längskommissuren der Tho racalganglien oder bei der Isolierung von Thoracalsegmenten führen die Ex

Giftwirkung von Dimetan und Pyrolan in Vergleich mit Parathion.

Tierart (Imagines)	„Dimetan"				„Pyrolan"				Parathion	
	DL 50		DL 100		DL 50		DL 100		DL 50	
	pro Tier in γ	pro Kg. K.gew. in mg	pro Tier in γ	pro Kg. K.gew. in mg	pro Tier in γ	pro Kg. K.gew. in mg	pro Tier in γ	pro Kg. K.gew. in mg	pro Tier in γ	pro Kg. K.gew. in mg
Plusia Gamma L.	10	30	12- 18	36- 54	8	24	10 - 12	30	2,5	7,5
Apis mellifica L.	1- 1,5	13	2	18	1- 1,5	13	2	18	0,1	1
Musca domestica L.	0,05- 0,07	3,2	0,3- 0,4	27	0,05- 0,07	3,2	0,3- 0,4	27	0,01	0,5
Ephestia kühniella Zeller	0,005	0,5	0,01- 0,0075	0,7- 0,75	0,005	0,5	0,0075	0,7	0,01	1
Aphis rumicis L.	0,0005	0,8	0,001	1,6	0,0005	0,8	0,001	1,6	0,0005	0,8

tremitäten den Tremor unabhängig von einander aus. Werden die Tiere m Barbitursäure gelähmt und alsdann eine „Dimetan"- oder „Pyrolan"-Lösun auf die Thoracalganglien gegeben, so entsteht in kurzer Zeit der typisch Beintremor, sodass also diesen Substanzen eine deutliche analeptische Wi kung zukommt.

Wird einer *Blatta* ein Gemisch von DDT-Wirksubstanz und „Dimetan" od „Pyrolan" injiziert, so zeigt sie einerseits den kurzschlägigen, für die DD Wirksubstanz typischen Beintremor und anderseits gleichzeitig den in rege mässigen Intervallen auftretenden Strecktremor. Aus diesen Beobachtunge sowie aus den Versuchen an den Thoracalganglien müssen wir schliesse dass bei diesen beiden Substanzen die Reizung nicht distal am Beinnerv e folgt, sondern zentral, im motorischen Teile des Ganglions. In dem von d DDT-Wirksubstanz verschiedenen Angriffspunkt und Wirkungsmechanism ist wohl der Grund zu suchen, dass mit diesen Produkten z.B. auch Flieg bekämpft werden können, die gegen DDT-Produkte und andere chlorien Kohlenwasserstoffe resistent sind.

Die Atmung wird bei der Einwirkung von „Dimetan" und „Pyrolan" dur den Beintremor stark übersteigert. Gleichzeitig findet auch eine abnorm hohe Wasserabgabe statt. Sie beträgt z.B. bei den mit diesen Substanzen ve gifteten Fliegen das Doppelte als bei den normalen.

Bei den vergifteten Küchenschaben erniedrigen sich die pH-Werte in d Muskeln und im Blute, was jedenfalls auf eine starke Milchsäureprodukti infolge des Tremors schliessen lässt. Es ist deshalb möglich, dass der dur diese Substanzen verursachte Tod hauptsächlich auf eine Erschöpfung, ve bunden mit einer Autointoxikation zurückzuführen ist.

Nach den Untersuchungen von PULVER weisen beide Substanzen, ab vor allem das „Pyrolan", eine sehr starke Anticholinesterasewirkung auf.

Werden „Dimetan" oder „Pyrolan" auf Pflanzen gespritzt oder zu den W zeln gegeben, so dringen sie dank ihrer lipophilen und hydrophilen Eige schaften in die pflanzlichen Gewebe ein und werden dort im anorganisch und organischen Saftstrom geleitet. Im letzteren können sie von den Bla läusen aufgenommen werden, die, wie wir gesehen haben, per os auf minir Substanzmengen reagieren. Vom pflanzenphysiologischen Standpunkt aus i es natürlich von Interesse zu beobachten, welchen Einfluss die Anwese heit dieser Substanzen in den pflanzlichen Zellen auf deren Funktionen au üben. Es zeigt sich, dass sie in den für die Blattlausbekämpfung notwendig Konzentrationen, Wachstum, Zellteilung, Plasmabewegung, osmotische Z standsgrössen, Atmung und Transpiration nicht verändern. Dagegen könn bei der alkoholischen Gärung von Hefen und bei der Kohlenstoff-Assimilati grüner Pflanzen vorübergehende Störungen beobachtet werden. So setzt z. die Assimilation der Wasserpest, *Eloda canadensis*, in Lösungen von „Dim tan" oder „Pyrolan" nach 1-2 Tagen praktisch aus. Werden die Pflanz nach 4 Tagen in Wasser übertragen, so kommt die Assimilation wieder no mal in Gang. Im Vergleich zu der bei den Tieren festgestellten Hemmwirku der Cholinesterase wird es einmal interessant sein, festzustellen, welch

von den bei der Kohlenstoffassimilation wirksamen Fermenten durch diese Substanz gehemmt wird.

Die beiden Produkte verursachen also in Konzentrationen, die für die Blattlausbekämpfung notwendig sind, keine Schäden an den Pflanzen.

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DISCUSSION

Mr. **Zanon**: Welche waren die Anwendungskonzentrationen?

Mr. **Gasser**: 0.02 - 0.04% aktiver Substanz.

Mr. **Zanon**: Sind diese Präparate auch wirksam gegen andere Schädlinge mit saugenden Mundwirkzeugen (Akariden, Psylla, u.s.w.), ausser Aphis?

Mr. **Gasser**: Diese Präparate sind nicht genügend wirksam gegen Psylla, und fast gar nicht gegen Paratetranychus u.a. Spinnmilben im Obst- und Weinbau.

Mr. **Heinze**: Sind die benützten Stoffe geruch- und geschmacklos? Oder beeinflüssen sie spaterhin den Geschmack des Ernteguts?

Mr. **Gasser**: Beide Substanzen sind geruch- und geschmacklos.

FREILANDVERSUCHE UND -ERFAHRUNGEN MIT SELEKTIVEN INSEKTIZIDEN MIT TIEFENWIRKUNG

von

H. GROB
Basel, Schweiz

In den Jahren 1949 und 1950 wurden die beiden Substanzen „Dimetan" und „Pyrolan", über deren Eigenschaften im Referat von Dr. R.GASSER berichtet wurde, in eingehenden Freilandversuchen auf ihre insektizide Eignung geprüft. Die wichtigsten Erkenntnisse dieser Versuche sollen im folgenden angeführt werden.

Die Wirkungsbreite von „Dimetan" und „Pyrolan".

Versuche zur Bekämpfung von Bodenschädlingen (Larven von *Psila rosae* F, *Hylemyia brassicae* Bch. und *Agriotes* spec.) verliefen vollständig negativ. Ebensowenig gelang die Bekämpfung einer *Ceutorrhynchus*-Art, deren Larve innerhalb des Zwiebelrohres schädigt. Dagegen erwiesen sich saugende Insekten, vor allem die Aphiden als stark anfällig.

Das Wirkungsspektrum der beiden Substanzen „Dimetan" und „Pyrolan" deckt sich weitgehend. Es sind hauptsächlich die Aphiden des Obst- und Beerenobstbaues, die auf diese beiden Substanzen reagieren. Die Konzentration, die für das Zustandekommen dieser Resultate notwendig ist, beträgt 0,02% A.S.

Einige Blattlausarten, die am Gemüse schädigend vorkommen, erwiesen sich dagegen als mehr oder weniger resistent, so insbesondere *Brevicoryne brassicae* L. und *Myzus persicae* Sulz., während *Aphis fabae* Scop. mit gutem Erfolg vernichtet werden kann. Worauf diese Selektivität innerhalb der Aphiden zurückzuführen ist, ist noch nicht abgeklärt.

Interessant ist dann ferner das Resultat gegen verschiedene Spinnmilbenarten. *Bryobia praetiosa* Koch. lässt sich damit leicht in Schach halten, während andere Spinnmilbenarten wie *Metatetranychus ulmi* Koch. und *Tetranychus urticae* Koch. damit nicht bekämpft werden können.

Die Tiefenwirkung von „Dimetan" und „Pyrolan".

Diese Eigenschaft ist besonders bei der Bekämpfung jener Blattlausarten unumgänglich notwendig, die sich in Blattgallen oder in eingerollten Blättern aufhalten.

Bestreicht man z.B. die Blattoberseite eines Blattes mit einer 0,02%-igen Lösung dieser Produkte, so gehen die auf der Unterseite des Blattes saugenden Blattläuse nach 24 Stunden vollständig ein. Die Aktivsubstanz der beiden Aphizide traversiert nicht nur das Blatt, sondern wird in den Saftstrom aufgenommen und vermag darin zu zirkulieren. Zur Demonstration dieser Eigenschaft führen wir aus unserem Versuchsmaterial folgendes Beispiel

aus dem Jahre 1949 an: Wir hüllten einige stark mit *Aphis pomi* de G. befallene Endtriebe eines Apfelbaumes so ein, dass bei einer Behandlung des Baumes diese Blätter keinen Spritzbelag erhalten konnten. Die Resultate sind in der folgenden Tabelle 1 zusammengestellt.

Tabelle 1

Versuche zur Abklärung der Tiefenwirkung von „Dimetan" und „Pyrolan" verglichen mit Parathion.

Zu- oder Abnahme der Blattläuse in % des Anfangsbestandes

	Abnahme bei:			Zunahme bei:
Zeit nach Behandlung	„Dimetan" 0,02% AS	„Pyrolan" 0,02% AS	Parathion 0,04% AS	unbehandelt
nach 12h	66,2	62,2	27,3	
36h	68,9	66,3	33,4	+ 4,7
60h	70,1	80,4	77,0	
86h	89,4	91,8	82,0	+ 16,1
110h	92,4	96,7	90,6	
134h	95,1	97,5	93,9	+ 8,4
158h	96,1	97,8	95,0	
182h	98,0	98,8	96,5	
206h	99,0	99,4	98,3	+ 13,5

Die Blattlauspopulation an diesen eingehüllten, nicht behandelten Blättern nimmt stark ab. Dies ist nur möglich, wenn die Substanz in den Saftstrom eingetreten ist, und in die unbehandelte Triebspitze geleitet wurde, wo sie von den Blattläusen per os aufgenommen wurde.

Diese innertherapeutische Wirkung liess sich, bei gleicher Versuchsanordnung, auch am Pfirsichbaum bei der Bekämpfung von *Hyalopterus arundinis* F. feststellen.

Bei der Wiederholung dieser Versuche im Jahre 1950 zeigte es sich, dass die Tiefenwirkung der beiden Substanzen stark von abiotischen Faktoren abhängig ist. Es ist diese eine Bestätigung der Laborerfahrungen, die im vorangegangenen Referat erwähnt wurden. „Dimetan" reagiert allerdings stärker auf Änderungen von Temperatur und Luftfeuchtigkeit als „Pyrolan".

Die Anfangswirkung von „Dimetan" und „Pyrolan".

Um uns über diese Eigenschaft für verschiedene Aphizide ein Bild zu machen, wendeten wir folgende Methode an: An vier, mit *Hyalopterus arundinis* dicht besiedelten Stellen eines Pfirsichbaumes wurden Fangtrichter aufgehängt, worin die abfallenden Individuen gesammelt wurden. Diese Trichter wurden in regelmässigen Abständen geleert und der Inhalt gezählt. Ausserdem wurden die an den Bäumen verbliebenen toten und lebenden Blattläuse 26 Stunden nach der Behandlung kontrolliert.

In Bezug auf Anfangswirkung steht „Dimetan" deutlich an der Spitze, da bereits 20 Minuten nach der Behandlung mehr als 90 % der Blattlauspopulation van den Blättern fiel. Nach einer Stunde waren ca. 98 % der Blattläuse vernichtet. „Pyrolan" ist in seiner Anfangswirkung weniger rapid, der nachträgliche Totenfall ist aber so stark, dass sich mit dieser Substanz nach 60 Minuten 97% der Population vernichtet wurde.

Bei den Vergleichsprodukten wirkt Nikotion am schnellsten, wird aber in seiner aphiziden Wirkung von Parathion deutlich übertroffen. Die Direktwirkung einer Hexa-Emulsion deckt sich anfänglich mit derjenigen von Parathion, ergibt aber schlussendlich mit 90,13% den geringsten Mortalitätsprozentsatz aller geprüften Produkte.

Abklärung der Wirkungsdauer von „Dimetan" und „Pyrolan".

Den bis anhin gebräuchlichen Aphiziden geht eine Dauerwirkung vollständig ab. Dieser Mangel macht sich besonders bei der Bekämpfung jener Blattlausarten geltend, wo mit stets andauernder Neuinfektion der Wirtspflanze gerechnet werden muss, während bei sesshaften Arten die gute Aphizid-Wirkung der Produkte ausschlaggebend ist.

Aus diesem Grunde war bis anhin eine erfolgreiche Bekämpfung der Virus-übertragenden *Myzodes-persicae* unmöglich, da andauernder Neuzuflug die Bildung neuer Kolonien auf den Kartoffeln ermöglichte. Doch sind auch im Obstbau Aphizide mit länger andauernder Wirkung wünschenswert. So z.B. bei der Bekämpfung der nicht wirtswechselnden *Aphis pomi* wo die Art durch die geflügelte Form van Baum zu Baum verbreitet werden kann. Ebenso bei *Hyalopterus arundinis* wo bei starker Besiedlung des Baumes ungeflügelte Individuen abwandern und benachbarte Bäume besiedeln.

Um der Frage der Wirkungsdauer der Substanzen nachzugehen, bedienten wir uns folgender Methode: In regelmässigen Intervallen wurden die mit „Dimetan", resp. „Pyrolan" behandelten Bäume mit der entsprechenden Blattlausart infiziert und der Populationsverlauf während der nachfolgenden Tage ständig kontrolliert.

Von den beiden Produkten zeichnet sich besonders „Pyrolan" durch eine auffallende Wirkungsdauer aus. 10 Tage nach der Behandlung vermag „Pyrolan" die neu aufgesetzte Population von 790 *Aphis pomi* noch vollständig zu vernichten. Allerdings geht mit dem Älterwerden des Belages auch eine Abschwächung der Wirkungsschnelligkeit einher, denn es braucht immerhin 6 Tage bis die neue Population vollständig vernichtet ist.

18 Tage nach der Behandlung ist der „Pyrolan"-Belag immer noch wirksam gegen *Aphis pomi.*

„Dimetan" dagegen wirkt nur ca. 4 Tage lang und entspricht in seiner Leistung ungefähr dem Parathion.

In den Versuchen gegen *Hyalopterus arundinis* wurde auch Tetra-dimethyl-amino-pyrophosphat 0,25 % A.S. einbezogen, das in dieser Konzentration sowohl dem „Pyrolan" und dem „Dimetan" überlegen war. Es vermochte während drei Wochen die stets neu aufgesetzte Blattlauspopulation fast vollständig zu vernichten.

Versuche zur Abklärung der Einwirkung verschiedener Aphizide auf die Insektenfauna eines Apfelbaumes.

Die Untersuchungen im Laboratorium haben gezeigt, dass die Dosis letalis für die verschiedenen Insektenordnungen stark variiert. Es sind besonders *Aphiden* und *Dipteren*-Imagines, die schon auf niedere Konzentrationen anfällig sind. Die in Tabelle 2 wiedergegebenen Resultate wurden folgendermassen gewonnen: Ein stark mit Spinnmilben und Blutläusen befallener Apfelbaum wurde mit dem entsprechenden Aphizid behandelt, und die durch das Mittel beeinträchtigten Insekten wurden in Fangtrichtern aufgefangen. 48 Stunden nach der Behandlung wurden sämtliche Versuchsbäume nochmals mit 0,03% Parathion behandelt. Diese starke Parathion-Konzentration erlaubt auch die von der Aphizidbehandlung verschonten Insekten abzutöten. Diese Methode gestattet uns weitgehend ein Urteil über die Agressivität eines angewendeten Aphizides zu bilden.

Aus unserem grossen Versuchsmaterial seien nur die wichtigsten Resultate zusammengefasst.

Tabelle 2

Einwirkung einiger Aphizide auf die Insektenfauna

Insekten	abgetötet durch:			
	„Dimetan"	„Pyrolan"	Nikotin	H.C.H.
Anthocoris nemorum L. & *Orius minutus L.*	29 = 23%	82 = 21%	74 = 73%	59 = 53%
Anthocoridae div. spec.	5 = 10%	12 = 10%	22 = 55%	16 = 44%
Chalcididae div. spec.	18 = 8%	68 = 27%	67 = 41%	48 = 54%
Aphelinus mali Hald.	709 = 20%	357 = 38%	1261 = 66%	169 = 61%
Ichneumonidae	1 = 20%	2 = 13%	5 = 52%	5 = 71%
Syrphidae Imag. div. spec.	6 = 30%	31 = 57%	0 = 0%	2 = 66%
Syrphidae Larv.	25 = 18%	55 = 74%	58 = 38%	45 = 70%
Diptera div. sp.	55 = 61%	485 = 61%	28 = 45%	17 = 38%
Chrysopidae Imag. div. spec.	2 = 29%	0 = 0%	5 = 62%	-
Chrysopidae Larv.	40 = 11%	33 = 11%	117 = 33%	56 = 30%

Die in Tabelle 2 zusammengestellten Resultate zeigen deutlich, dass die beiden neuen Substanzen „Dimetan" und „Pyrolan" viel weniger agressiv auf die Nützlingsfauna einwirken als die Vergleichsprodukte Nikotin und HCH-Emulsion. Von allen geprüften Substanzen ist „Dimetan" am harmlosesten. „Pyrolan" schädigt ebenfalls nur in kleinem Masse die *Anthocoriden*-Schlupfwespen und *Chrysopa*-Fauna, schlägt dagegen eine empfindliche Lücke in die *Dipteren*-Fauna, wobei auch die *Dipteren*larven stark dezimiert werden.

Zusammenfassung.

1. „Pyrolan" und „Dimetan", Derivate der Urethan-Reihe, erwiesen sich als starke Aphizide, wobei sich mit beiden Substanzen besonders die Aphiden des Obst- und Beerenobstbaues bekämpfen lassen, während sich einige Aphiden des Gemüsebaues als überraschend resistent erwiesen.
2. Beide Substanzen vermögen ins Blatt einzudringen und im Saftstrom zu zirkulieren. Diese Tiefenwirkung ist allerdings von abiotischen Faktoren abhängig, wobei „Pyrolan" schwächer auf Änderungen der Temperatur und der Luftfeuchtigkeit reagiert als „Dimetan".
3. In Bezug auf Anfangswirkung übertreffen sie alle bis anhin bekannten Aphizide.
4. „Pyrolan" wies sich über lange Wirkungsdauer gegen *Aphis pomi* aus.
5. Beide Aphizide wirken weitgehend selektiv.

DISCUSSION

Mr. **Martin:** Has the vapour pressure of either compound been determined?

Mr. **Grob:** Der Dampfdruck wurde bestimmt und ist sehr hoch. Beide Substanzen sind wasserdampfflüchtig.

Mr. **Ketelaar**: Ist es dann gesichert dass es sich um eine Tiefenwirkung und nicht um eine Wirkung des Dampfes handelt?

Mr. **Grob:** Die Versuche wurden so angelegt, dass Dampfwirkung und innertherapeutische Wirkung auseinander gehalten werden konnten, wobei die Substanzen eindeutig eine innertherapeutische Wirkung zeigten.

THE STATUS OF THE SPRAY RESIDUE SITUATION IN THE UNITED STATES *)

by
Albert HARTZELL
Yonkers 3, N.Y., U.S.A.

The present spray residue situation is reminiscent of the arsenic and lead scare of the 1920's. The increase in resistance of the larvae of the codling moth (*Carpocapsa pomonella* L.), required the fruit growers of that period to apply additional sprays that raised the total arsenic and lead present on the surface of the sprayed fruit to dangerously high levels for human consumption. The present residue situation has arisen principally because chlorinated hydrocarbons and organic phosphate insecticides after World War II were synthesized and released at a rate faster than safe usage would warrant. The situation was further complicated by the fact that analytical methods for the detection of these materials in foods were inadequate and in some cases completely lacking. Except for DDT, comparatively little was known regarding animal toxicity of the newer compounds so that there was much uneasiness on the part of the public as to the safety of the food supply. That this fear was not groundless is borne out by LEHMAN's (12) estimates of the acute oral toxicities of parathion as 70 times and TEPP as 125 times that of DDT.

During November 1948, and March and April 1949, the writer made a survey of the spray residue situation on the West Coast in the States of California, Oregon and Washington, paying particular attention to the fruits and vegetables that are processed by the canning industry – apples, pears, peaches, apricots, prunes and oranges among fruits, and celery, peas and spinach among vegetables. In California, the Citrus Experiment Station at Riverside, the State Department of Adult Health laboratories and the State University at Los Angeles and Berkeley were visited. In Oregon, the State College at Corvallis and while in Washington the Tree Fruit Experiment Station at Wenatchee, and the State College at Pullman were contacted to find out at what levels the spray residues were present and also what measure were being taken to remove the residues from sprayed fruit and vegetables. This information was of special interest because the precipitation averages less than 10 inches in the citrus area in Southern California, and in the apple and pear growing districts in Western Washington, from fruit set to harvest, allowing little or no opportunity for the spray residue to be washed off by rain.

In California, a large vegetable growing area and packing house at Salinas

*) Acknowledgment is due to Beech-Nut Packing Co., Canojoharie, N.Y., and to the National Canners Association, Washington, D.C., for their cooperation.

was visited as was also a cannery at San José, for the purpose of observing conditions of harvesting, packing and processing fruits and vegetables.

Chemists in charge of the control laboratories of canneries in the San Francisco area were interviewed as to the analytical methods employed for the detection of spray residues and questioned as to the advisability of supplementing these tests with bioassay methods. Bioassay tests involving the use of mosquito larvae on sprayed fruit shipped by air express to Yonkers, N.Y. from California during the season of 1948 had shown that the residue on apricots that had been sprayed with DDT (50% wettable powder) at the rate of 1.5 pounds per 100 gallons of water was toxic to mosquito larvae (9). These tests were preliminary as precision bioassay methods had not as yet been worked out.

With the substitution of parathion for arsenate of lead the apple and pear growers of the Pacific Northwest found that they could reduce the number of spray applications from 12 or more to one or two and still obtain commercial control of codling moth. By allowing a 30-day period for the last application of parathion till harvest, WALKER (16) reports residues of less than 1 p.p.m. Typical parathion spray residues on oranges at harvest time in California, according to BARNES et al. (3), ranged from 0.01 to 0.20 p.p.m. following two applications of parathion, the last 120 days prior to harvest. On vegetables, ROBINSON (14) found 0.08 p.p.m. of parathion on beans and 0.21-0.04 p.p.m. on cauliflower. In a more humid region, WESTLAKE and FAHEY (17) reported less than 0.2 p.p.m. on fruit in the Mississippi Valley, that had been sprayed 40 days prior to harvest.

The situation in regard to DDT residues was less favorable than with parathion (17), with 3-4 p.p.m. not uncommon, although the residue on most fruit was well below the then proposed tolerance of 7 p.p.m. On citrus fruits (3), the residues usually fell below 2.5 p.p.m. On asparagus, ROBINSON (14) found 6.4 p.p.m., on corn (maize) a trace, peas negative and tomatoes from 0-1.8 p.p.m. on vegetables sprayed 9 weeks prior to harvest. The results reported with animal food products were disconcerting. Only two references can be cited here of an increasing literature on this subject. When dairy cows were fed DDT-treated hay that had been sprayed with DDT from 0.5 to 4.0 pounds per acre, DDT was found in the milk within 4 days and gradually increased to a maximum of 12.5 p.p.m. Furthermore it persisted in the milk for 4 months and disappeared approximately 6,5 months after the feeding of DDT-treated hay was discontinued (4). The danger of milk contamination was considered so serious that the use of DDT for fly control in dairy barns has been generally discontinued throughout the United States. DDT was found also in eggs and the tissues of chickens (5) fed varying levels of DDT. Average amounts present in the fat of chickens ranged from 30.3 to 502.6 p.p.m. in poultry fed alfalfa hay that had been treated with 1 to 4 pounds of DDT per acre. The concentration in eggs ranged from 1.7 to 65.6 p.p.m. for hens fed mash containing from 0 to 200 p.p.m. of DDT.

Much progress has been made in the determination of new insecticides of

the chlorinated hydrocarbon and the phosphorus-containing compounds. Methods for determining composition and purity of commercial grades have been developed, but only a few procedures according to HALLER (8) are available for their detection and evaluation in dusts, oil solutions, emulsions, concentrates and aerosols. When more than one insecticide is present in a mixture difficulties of determination are encountered. The colorimetric method of SCHECHTER-HALLER (15) is used in the determination of DDT, benzene hexachloride, chlordan and toxaphene, while the AVERELL-NORRIS (2) method generally is used for the detection of organic phosphorus insecticide spray residues. The chemical analytic methods are supplemented by bioassay methods involving the use of houseflies of HOSKINS and MESSENGER (11) or the use of mosquito larvae of NOLAN and WILCOXON (13), and HARTZELL and STORRS (10). The last named method has recently been perfected by BURCHFIELD into a precision bioassay by taking advantage of the negative phototropic response of mosquito larvae.

One of the benefits of improved analytical methods has been the processors' control of insecticide in foods. Contracts with growers, stating that fruits and vegetables containing certain chemicals will not be accepted, can be enforced. A general chemical policing policy including analytical chemical and bioassay tests of fresh fruits and vegetables and processed foods is an accepted part of all processing firms that are striving for a high quality pack. This voluntary policing on the part of the food processors has made law enforcement by the Food and Drug Administration easier. That not a single authentic case of acute food poisoning due to insecticides has been reported is a credit to all concerned. That this favorable record may not continue indefinitely with the present rapid synthesis and release of organic insecticidal compounds is a subject of which there may be an honest difference of opinion. The Food and Drug Administration has conducted hearings on the need for various insecticides with the view of establishing tolerances. Doubts have been expressed as to the efficacy of the present Food, Drug and Cosmetic Act, mainly for intentional additives to food. There appears to be less concern regarding spray residues. At a hearing before the select committee of the House of Representatives (6) many witnesses expressed the opinion that new insecticides were not tested sufficiently to determine their toxicity to warm-blooded animals before being put on the market. It was estimated that it would cost from $20,000 to $50,000 to make adequate toxicity tests for a new insecticide. At the present time toxicological tests are required by the insecticide manufacturer for acute oral toxicity, skin absorption and inhalation on at least two species of laboratory animals. It has been proposed that chronic toxicity tests for two years also should be required. The Food and Drug Administration also runs a parallel series of tests and such additional tests as it seems advisable. If the new insecticide is safe, within certain limits, the manufacturer is permitted to distribute and sell the product in inter-state commerce. Thirty-nine of the 48 states in the Union also have laws covering the distribution and sale of insecticides.

The situation in regard to the hazard in manufacturing and applying the newer insecticides leaves much to be desired. ABRAMS et al. (1) report a total of 198 cases of poisoning due to organic phosphorus insecticides, including 8 fatalities compiled from public health records. The American Medical Association has organized a Committee on Pesticides to coordinate information on economic poisons and make available to physicians prophylactic and antidotal measures (7). The Food Protection Committee of the National Research Council functions unofficially as an advisory council to the Food and Drug Administration.

In conclusion, the spray residue situation in the United States, while serious, is well in hand. Not a single authentic case of poisoning has been reported as due to spray residues. Several fatalities have been reported in the manufacture, handling and application of phosphorus-containing insecticides. One need not assume the role of a prophet to predict a tightening of government controls over insecticides, including the requirement of more comprehensive toxicological tests before a new insecticide is released for distribution and sale.

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DISCUSSION

Mr. **Pal**: Were the results obtained by the chemical estimation and biological assaying technique closely comparable?

Mr. **Hartzell**: In general there was fair to good correlation between the bioassay results and chemical analytical tests.

Mr. **Pal**: Was there any specific reason for using mosquito larvae?

Mr. **Hartzell**: Previous work by myself and associates had indicated that mosquito larvae are extremely sensative to insecticides.

Mr. **Bishopp** comments: We in the United States feel that the development of standardized bioassay methods is especially desirable and necessary in the case of those insecticides such as toxaphene and chlordane for which no specific chemical methods of analysis are available. Also it appears that in some instances bioassay methods may be more accurate and less time consuming than chemical ones. We are striving for their further development and hope that bioassay methods may be acceptable to food control agencies.

QUELQUES APPLICATIONS DU PARATHION AUX CULTURES EUROPEENNES AU KATANGA

par

J. VEKEMANS

Kaniama, Congo Belge

Le diethyl-nitrophenyl-thiophosphate fut introduit à la Station Inéac de Kaniama dans le but principal de lutter contre le *Myzus persicae*, Sulz. qui certaines années provoque de graves dégâts aux cultures de tabac.

Trois essais systématiques y furent entrepris.

1°. Dans le premier essai les traitements suivants furent mis en comparaison.

(1) Gesaphide: 1,5% dans l'eau à raison de 850 l/ha. Le Gesaphide est une solution contenant 10% de DDT et un mouillant qui le rend efficace contre les pucerons.

(2) Nixane E: 0,25% dans l'eau à raison de 850 l/ha. C'est un insecticide à base d'ether sulfodiethylique.

(3) Extrait de nicotine: 0,33% de nicotine dans l'eau à raison de 850 l/ha. Dose particulièrement forte.

(4) Parathion: Thiophos W.P. 15%: 0,33% de parathion pur dans l'eau à raison de 850 l/ha.

(5) Parathion Dust 1%: 27 Kg/ha, c.à.d. 270 g de parathion pur par ha.

L'essai s'est fait en 6 répétitions et les lectures sont rassemblées en index. Ceux-ci expriment un nombre de feuilles portant des pucerons vivants. Par traitement, 120 plantes sont examinées au hasard, l'index théorique correspondant à 100% d'attaque serait donc 480.— 4 feuilles sur 120 plantes.

Le résultat des traitements après 6 jours peut être résumé comme suite:

Traitements	Index	Moyennes	% d'attaques
(1) Gésaphide	326	54,3	67,9
(2) Nixane E	402	67,0	83,7
(3) Extrait de nicotine	348	58,0	72,5
(4) Thiophos W.P. 15%	170	28,3	35,4
(5) Thiophos Dust	391	65,1	81,4
(6) Témoins	422	70,4	87,9
Index théorique maxim.	400	120,0	100

P.P.D.S. à P.0,01 = 14,978
P.0,05 = 11,397

Le traitement au Thiophos W.P. 15% est donc bien supérieur aux autres traitements. Le traitement au Thiophos Dust 1% n'a pas donné de résultats

favorables par suite de défectuosité du matériel. Ce fait fut mis surtout en évidence par les résultats des essais ultérieurs.

2°. Dans le deuxième essai le parathion fut utilisé à différentes doses et l'effet de rémanence fut contrôlé. Il comportait la série de traitements suivants:

(1) Thiophos W.P. 15: 0,03% de parathion pur, à raison de ± 1000 l/ha.
(2) „ „ „ 0,015% „ „ „ „ „ „
(3) „ „ „ 0,0075% de „ „ „ „ „ „
(4) Gesaphide : 0,15% de DDT „ „ „ „
(5) Nicotine 98% : 0,098% de nicotine „ „ „ „
(6) Sulfate de nicotine: 0,080% „ „ „ „ „
(7) Thiophos Dust 2%: environ 10 Kg/ha.
(8) Thiophos Dust 1%: „ „ „
Témoin.

Les observations effectuées sur 216 feuilles par traitement sont réunies dans le tableau cidessous.

Trait.	1ère lecture			2ème lecture			Réinfection	
	Index	Moy.	% d'att.	Index	Moy.	% d'att.	Moy.	% Réinf.
1	0	0	0	27,8	9,26	12,87	+9,26	+12,87
2	30	10	13,88	49,6	16,53	22,96	+6,53	+ 9,08
3	6	2	2,77	33,8	11,26	15,64	+9,26	+12,87
4	19	6,3	8,79	31,0	10,33	14,35	+4,00	+ 5,56
5	189	63	87,50	129,4	43,13	59,90	-19,87	-27,60
6	184	61,3	85,18	138,4	46,13	64,07	-15,20	-21,11
7	5	1,6	2,31	8,2	2,73	3,79	+1,07	+ 1,48
8	1	0,3	0,46	30,0	10,00	13,88	+9,66	+13,42
Tém.	197	65,6	91,20	142,0	47,33	65,74	-18,27	-25,46
I.T.M.	216	72	100	216	72	100	0	0

P.P.D.S. P.0,01 = 17,94 P.0,01 = 20,25 P.0,01 = 9,71
P.0,05 = 13,32 P.0,05 = 15,04 P.0,05 = 7,21

L'efficacité des traitements au Thiophos est confirmée dans cet essai. L'effet de rémanence est remarquable pour le Thiophos 2% et pour le Gesaphide.

A part le traitement 2 qui est légèrement faussé par suite d'une mauvaise application, les pulvérisations même à faible concentration sont supérieures aux poudrages qui utilisent cependant une plus forte proportion de produit actif à l'ha. Dans les conditions de travail que l'on rencontre au Lomami, il faudra cependant tendre à effectuer les traitements par poudrages parce qu'ils apportent notamment les avantages suivants:

– contrôle aisé du travail effectué par une main d'oeuvre primitive et peu consciencieuse.
– homogénéité des résultats car toutes les plantes sont atteintes par le traitement quelle que soit la conscience professionelle du travailleur. Ceci n'est pas le cas pour les pulvérisations comme nous avons pu le constater, entre autres, pour le traitement 2.
– réduction du coût des applications par suite de la rapidité du traitement, de l'absence de transport d'eau, de matériel plus robuste et moins onéreux.

Par ailleurs les poudrages entrainent aussi quelques inconvénients parmi lesquels nous retiendrons l'utilisation d'une plus grande quantité de produit actif à l'ha et la nécessité d'un volume important de matières de charges qui grèvent fortement le fret de ces produits. Cet inconvénient est capital au centre d'un continent non producteur de produits phytopharmaceutiques. Il a d'ailleurs retenu notre attention et afin de l'éviter, une tentative de dilution de Thiophos concentré au moyen de matières de charge locales fut ébauchée. Il s'agissait en l'occurence de poudre de tabac stérilisée.

3°. Ce fut l'objet du troisième essai qui comprenait les traitements suivants:

(1) Vapotone XX à 20 % de tetra-ethyl-pyrophosphate: 0,02 % de produit actif dans l'eau.
(2) Thiophos W.P. 15 %: 0,03 % de produit actif dans l'eau dose normale.
(3) „ „ „ : 0,00375 % de „ „ „ l'eau 1/8 de dose.
(4) Thiophos Dust 1 % : commercial: 20 Kg /a.
(5) Thiophos Dust 2 % : dilution de Thiophos W.P. 15 dans de la poudre de tabac non tamisée.
(6) „ „ 0,5 %: dilution de Thiophos W.P. 15 dans de la poudre de tabac tamisée.
(7) „ „ 0,125 % : dilution de Thiophos W.P. 15 dans de la poudre de tabac tamisée.
(8) Témoin non traité:

Les résultats découlent de comptages effectués sur 480 feuilles par traitement.

Traitement	Index	Moyenne	% d'attaque
(1)	211	52,75	43,95
(2)	108	27,00	22,50
(3)	198	49,50	41,25
(4)	51	12,75	10,62
(5)	82	20,50	17,08
(6)	118	29,5	24,58
(7)	277	69,25	57,70
Témoin	418	104,50	87,08
Index théo.Max.	480	120	100,00

P.P.D.S. à P. 0,01 = 37,86
à P. 0,05 = 27,82

Ici encore l'intérêt du parathion est indubitable. Le Vapotone XX utilisé à faible dose par crainte de la toxicité n'est pas utile à cette concentration. Les pulvérisations au Thiophos W.P.15 dilué même au 1/8 de la dose normale sont encore efficaces. En effet le traitement 3 correspond à environ 250 g de Thiophos W.P.15 à l'ha, c.à.d. 37,5 g de parathion pur par ha, alors que la dose normale serait de 300 g de parathion pur par ha.

Ceci ne fait que renforcer les résultats précédents. Il en est de même, au sujet des poudrages qui sont également efficaces, mais nécessitent une plus grande quantité de produit actif à l'ha, pour un résultat analogue. Voici d'ailleurs les quantités réparties sur un ha, pour les différents traitements par poudrage.

Traitement	Titre	Dose
5	2%	400 g/ha
4	1%	200 g/ha
6	0,5%	100 g/ha
7	0,125%	25 g/ha

Quoiqu'il en soit la dilution de parathion dans la poudre de tabac parait être une opération intéressante. Même à 0,5% de produit actif dans de la poudre de tabac tamisée le traitement donne des résultats. Par ailleurs le traitement 5 à base de poudre non tamisée titrant 2% de produit actif n'est pas sensiblement supérieur au traitement 6 qui ne titre que 0,5%, mais est préparé à base de poudre de tabac tamisée. Il semble donc que l'utilisation de poudre de tabac stérilisée et tamisée de production locale pourrait être la solution du problème d'un traitement économique et rapide dans la lutte contre *Myzus persicae* Sulz. parasitant le tabac dans le Haut-Lomani.

Dans une autre domaine, des résultats provisoires ont été acquis par suite de l'action du parathion sur *Heterodera marioni* Goodey. Les résultats de DIMOCK,A.W. et LEAR,B., 1950(a) d'une part et de ELLIS,D.E. et CLAYTON, C.N., 1948 (b) d'autre part son contradictoires.

Deux tests ont été mis sur pied en pépinières de tabac. En quinze jours 4 arrosages de suspensions de parathion ont permis de réduire notablement la proportion de larves vivantes dans les racines. Les comptages ont été fait suivant une méthode analogue à celle de GRAHAM, T.W. (c) utilisée par OWENS, R.G. & ELLIS, D.E. 1951 (d)(e) et les résultats furent les suivants:

1er Test:

Trait.	Concentration en Thiophos W.P.15	Nb.de larves libérées dans 10 g de rac.	% Témoin.
A	60 $g/m^2/15$ jours	58,75	31,5
B	40 $g/m^2/15$ jours	28,125	15,1
C	20 $g/m^2/15$ jours	28,75	15,4
Témoin		186,25	100,0

2ème Test:

Trait.	Concentration en Thiophos W.P.15	Nb.de larves libérées dans 10 g de rac.	% Témoin.
	60 g/m^2/15 jours	18,4	4,6
Témoin		397,5	100,0

La réduction d'infection est notable bien que les jeunes plantes de tabac ne paraissent pas en avoir souffert. Celles-ci prirent uniquement un aspect caractérisé par une nervuration plus prononcée. Il s'agit évidemment de mettre au point une méthode plus économique. Elle devrait permettre de lutter curativement contre l'Heterodera qui est généralement difficile à détecter au moment de l'établissement des pépinières sur sol vièrge.

Une autre culture est également susceptible d'amélioration par l'usage du parathion. Les pommes de terre en conservation sont fréquemment chargées de coccides du type mealybug qui y sont apportées par des fourmis diverses.

Ces coccides affaiblissent les tubercules en conservation et peuvent après la plantation provoquer le flétrissement de jets déjà fort développés. Des poudrages au Thiophos Dust 2% dans les magasins de conservation provoquèrent la disparition de la majorité de ces parasites qui furent totalement éliminés par trempage dans une suspension à 1% de Thiophos W.P.15 %, c.à.d. 0,15 % de produit actif.

Enfin les citrus fréquemment parasités par des lécaniées furent maintenus indemnes par trois pulvérisations à base d'huile minérale et de parathion. L'huile blanche utilisée précédemment à 2% provoquait généralement des brûlures sur le feuillage jeune. Cette émulsion fut donc remplacée par l'émulsion à 1% additionnée de 0,4% de Thiophos W.P.15, c.à.d. 0,06% de produit actif.

Tous les traitements dont la relation précédé, ont été pratiqués moyennant un minimum de précautions indispensables comprenant le port de lunettes et d'un masque ordinaire filtrant les gaz organiques. Les travailleurs ne manifestèrent jamais de signe d'intoxication malgrè leur maintien pendant plusieurs heures dans une atmosphère chargée de particules de parathion.

Cependant, dans certains cas l'usage du parathion pourrait entrainer des accidents si l'on ne surveille pas la main d'oeuvre peu encline à prendre des précautions. Il ne faut pourtant pas pousser les choses au point de proposer la suppression de l'emploi de cet insecticide.

Que l'on nous permette à ce sujet cette simple comparaison entre la toxicité de la nicotine et celle du parathion. La dose léthale de 50% de population – D.L.50 – de la nicotine est proche de celle du parathion ou tout au moins du même ordre de grandeur. -Nicotine $\pm$ 20 mg/kg - (f)(g)(h).

Or, dans les essais énumérés ci-dessus, les concentrations les plus fortes de parathion sont toujours au moins 2 à 3 fois plus faibles que la concentration normale de nicotine. Ce qui plus est, par exemple dans le second essai, une suspension de Thiophos W.P. 10 fois moins concentrée que la solution

la plus faible de nicotine est très efficace (traitement 3 = 2,77% d'attaque) alors que le traitement à la nicotine ne diffère pratiquement pas du témoin (traitement 6 = 85,18% d'attaque). On peut en conclure que dans les conditions du Haut-Lomami l'usage de la nicotine est notablement plus dangereux que celui du parathion. Ces considérations ne tiennent pas compte des concentrations sous lesquelles les produits sont livrés au commerce. La nicotine est généralement fournie en solution concentrée alors que le parathion peut-être présenté sous forme de poudre mouillable de concentration relativement faible et de toxicité réduite.

Ces réflexions méritaient d'être mises en évidence afin qu'un souci exagéré de protection sanitaire ne puisse être une entrave à la rationalisation de certaines spéculations agricoles au Katanga notamment.

Summary

Le diethyl-nitrophenyl-thiophosphate s'est révélé très utile pour la protection de plusieurs cultures pratiquées par des colons européens au Katanga, Congo Belge.

Sur tabac parasité par *Myzus persicae*, Sulz., des doses normales de parathion abaissèrent le pourcentage des feuilles attaintes à 0% contre 90% environ pour les témoins. Des doses 8 fois plus faibles que la normale sont encore efficaces mais l'effet résiduel est alors plus limité. Les pulvérisations bien appliquées sont supérieures aux poudrages. Ces derniers sont cependant plus commodes, plus homogénes, plus aisement contrôlables et par conséquant mieux à portée d'une main d'oeuvre primitive.

Malheureusement, les matières de charge grèvent fortement le fret des produits à poudrer. Une tentative de dilution de parathion, concentré à 15%, dans de la poudre de tabac produite localement fut réalisée et l'application du mélange donna des résultats encourageants. La finesse de ce support inerte est sans doute un facteur de la réussite.

Le parathion peut également servir à la lutte contre *Heterodera Marioni*, Goodey, parasite des racines de tabac. Sa faible toxicité pour les végétaux permet de l'utiliser curativement. Des arrosages à raison de 60 g de parathion 15% par mètre carré réduisirent l'infection de 100 à 4,6% en deux semaines, sans effet nocif marqué sur les plantules.

La production et la conservation des tubercules de pommes de terre sont aussi facilitées par cet insecticide. Des poudrages au parathion 2% en magasin et un trempage des tubercules dans une suspension à 0,15% de parathion pur avant la plantation mirent en échec les attaques de coccides.

Enfin les Lécaniées parasites des Citrus ont pu être éliminées par des pulvérisations d'une émulsion à 1% d'huile minérale contenant 0,06% de parathion pur.

Seule la toxicité de ce composé vis à vis de l'homme est de nature à limiter son emploi. Cependant, si, comme on peut l'admettre, la DL 50 du parathion n'est pas inférieure à celle de la nicotine, la toxicité à l'usage du

parathion sera de loin inférieure à celle de la nicotine. A titre d'exemple, dans le cas de la lutte contre *Myzus persicae*, les suspensions de parathion utilisées, bien que sensiblement plus efficaces, sont le 3½ à 14 fois moins concentrées en produit toxique que la solution standard de nicotine.

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INSEKTIZIDE SAATSCHUTZMITTEL ZUR BEKÄMPFUNG VON WURZELSCHÄDLINGEN

von

E.GÜNTHART
Dielsdorf, Zürich, Schweiz

In unseren Versuchen in Dielsdorf zeigte sich, dass durch Beimischung ines Insektizides zum Saatgut gegen die Larven der Schalottenfliegen (*Hy-emyia cilicrura* Rond. und *Hylemyia trichodactyla* Rond.), die an keimenden ohnensamen oft Ausfälle bis zu 90% verursachen können (bei Silomais in inzelnen Fällen schwache Ausfälle), ferner gegen die Drahtwürmer (Larven on *Agriotes*-Arten) bei verschiedenen Sämereien eine Wirkung erzielt wer-en kann. Die ersten Resultate mit einem hexachlorcyclohexan-haltigen Saat-chutzmittel gegen die Larven der Schalottenfliege erhielten wir 1945; der rfolg hat sich seither immer wieder bestätigt. Die Wirkstoffdosis zur Erzie-ung einer Befallsreduktion bei den Schalottenfliegen von 80-90% betrug 2 - 40 - 48 - 60 g Gamma-Isomere von Hexachlorcyclohexan (=Lindan) je 00 kg Bohnensaatgut; die günstigste Präparat-Dosis ist 200 g eines pulver-örmigen Saatschutzmittels (Lindan + geeignetes Fungizid) auf 100 kg Boh-ensaatgut. Nur bei sehr starkem Befall, wie dies bei einzelnen Aussaaten n Frühjahr 1951 auftrat, sank die Wirkung etwas tiefer, war aber praktisch och voll befriedigend und die Konservenfabriken, die versuchshalber meh-ere 1000 kg Bohnensaatgut für den Vertragsanbau seit 2 Jahren so behan-eln, sind von der Wirkung sehr befriedigt.

Gegen Drahtwurmbefall bei verschiedenen Getreidearten, Mais, Zucker- und utterrüben führten wir seit 1949 mit Lindan-haltigen Saatschutzmitteln Ge-ächshaus- und Freiland-Versuche durch. Die Prüfung anderer Insektizide ist och nicht abgeschlossen doch gab in unseren Versuchen auch Dieldrin gute esultate. Am besten eignen sich pulverförmige, kombinierte Fungizid + Lin-an-Saatbeizmittel mit einem Gehalt von 20 - 30% Lindan, wovon auf 100 kg aatgut bei nacktem Samen 200 g, bei Getreidesaatgut in den Spelzen 300-00 g und bei Runkel- oder Zuckerübensamen in den Knäueln 600-1000 g ver-endet werden. Die Prüfung von flüssigen, insektizidhaltigen Saatbeizmit-eln ist noch nicht abgeschlossen.

In Freiland-Versuchen traten nur bei ca. 2% aller Felder anfänglich leich-e Keimhemmungen auf, die sich aber bald wieder auswuchsen. Im Gewächs-aus oder in Saatschalen im Labor kann aber bei gleicher Dosierung unter mständen ein Keimschaden beobachtet werden.

In Freiland-Versuchen konnten wir durch Ausschlämmung von Erdproben ach der Methode Cockbill nachweisen, dass durch die Saatgutbehandlung ine Reduktion von 25-75% der Anzahl Drahtwürmer im Boden erreicht wer-en kann. Doch beträgt die Reduktion im Frass an den Pflanzen meist mehr ls die Reduktion in der Anzahl Drahtwürmer. Wird die Anzahl Pflanzen in

Parzellen mit Saatgutbehandlung als 100 angenommen, so betrug die Reduktion der Anzahl Pflanzen bei Zuckerrüben in unbehandelten Parzellen vielfach 80-90 %, bei Getreide oft 20 %. Bei Herbstaussaaten könnte auch im folgenden Frühjahr noch eine deutliche Reduktion des Frasses nachgewiesen werden. In einem Fall trat bei Maiskörnern kurz nach der Saat bei unbehandelt ein Schaden durch Saatkrähen auf; bei Behandlung mit Lindan-haltigen Saatschutzmitteln konnte bei schwachem Krähenschaden eine Wirkung von fast 100% erzielt werden, bei Engerlinge (Larven von *Melolontha*)hat Lindan keine Wirkung.

In den Feldern, in denen in unbehandelten Parzellen ein deutlicher bis starker Drahtwurmschaden auftrat, konnte durch die Saatgutbehandlung bei Getreide, Grünmais und Zuckerrüben ein beachtlicher und gesicherter Mehrertrag erzielt werden, doch war besonders 1950/51 an vielen Orten auch in den unbehandelten Parzellen kein bedeutender Drahtwurmschaden aufgetreten, obschon die Landwirte damit rechneten. Wir führten z.B. im Herbst 1950 und im Frühjahr 1951 bei rund 100 Landwirten in verschiedenen Teilen der Schweiz verteilt Saatbeiz-Versuche gegen Drahtwürmer durch; in rund 2/3 der Fälle trat auch in den unbehandelten Parzellen kein Schaden auf und somit kein Unterschied zwischen behandelt und unbehandelt, in 1/3 der Fälle war aber bei unbehandelt ein schwacher bis sehr starker Drahtwurmschaden, der durch die Saatgutbehandlung fast vollständig, oder bei stärkem Befall doch praktisch befriedigend verhütet werden konnte. Gerade dieser Umstand dass der Drahtwurmschaden nicht immer von der Grösse der Drahtwurmpopulation abhängt und daher nicht sicher vorausgesagt werden kann, spricht für eine relativ billige und einfache, vorbeugende Drahtwurm-Bekämpfung, wie dies mit den insektiziden Saatschutzmitteln der Fall ist.

Durch gleichmässige Flächenbehandlung des Bodens vor der Saat mit einem Hexa-, Lindan- oder Chlordan- Streumittel kann ein noch etwas besserer Schutz der Pflanzen und eine höhere Reduktion der Anzahl Drahtwürmer im Boden erreicht werden, doch ist die verwendete Insektizidmenge fast 10 mal grösser und das Eindringen dieser Insektizide in die Wurzelteile, in Kartoffeln, Futterrüben, Möhren etc. noch zu wenig abgeklärt und wir empfehlen daher vorläufig, nach solchen Bodenbehandlungen während 2-3 Jahren keine Kartoffeln oder ähnliche „Wurzelfrüchte" anzubauen. Nach Behandlungen des Saatgutes von Getreide oder Zuckerrüben konnten wir hingegen schon im folgenden Jahr bei Kartoffeln und Rettich keine ungünstige Geschmacksbeeinflussung feststellen.

DISCUSSION

Mr. **Dosse** remarks: Um Irrtümer zu vermeiden wird in Deutschland der Ausdruck „Beizung" nur bei fungiziden Wirkung verwendet. Bei insektiziden Wirkung spricht man von „Einpuderung".

Mr. **van 't Sant**: Which method has speaker used for seed dressing?

Mr. **Gunthart**: Gleiche Methode wie für Trockenbeizmittel. Mischen in Beiztrommel oder Behandlung mit grösseren speziellen Beizmachinen.

AERIAL SPRAYING AGAINST AUSTRALIAN PIAQUE LOCUST IN VICTORIA

by
T. W. HOGAN
Melbourne, Victoria, Australia

The Australian Plague Locust (Chortoicetes terminifera W.) is indigenous to Australia and has its main outbreak centres in the inland region of the eastern part of the Continent. No outbreak centres exist in Victoria, in the South-east of Australia, but we are occasionally faced with what might be termed an "overflow" from the North and West whenever conditions are unusually favourable to the locusts in those areas.

Sometimes invading swarms may deposit eggs and one generation be completed in Northern Victoria, and other times flying swarms may arrive and die out before egg-laying, or the eggs deposited fail to hatch. It can be realised therefore that the problem is different and rather more straightforward than those states in which outbreak centres exist. We have a direct interest, however, in preventing outbreaks at their source, should it be practicable, and consideration of such measures has been given by N.S.W. Victoria, South Australia and the Commonwealth Government over the past few years.

Pending any long term solution, crop protection methods have to be employed as outbreaks occur. When ovipositing swarms occurred in Northern Victoria in the autumn of 1946 tests were made with the spraying of insecticide from the air against them and satisfactory results obtained. As extensive egg-beds were established plans for the control of the spring brood included aerial spraying as a supplement to baiting. Four Beauforts were supplied and operated by the R.A.A.F. and the spraying proved so successful that it quickly became the main method of control. It became the only method used against the flying stage, where baiting is not satisfactory.

In 1950 flying swarms entered Victoria threatening wheat crops and irrigated pastures and aerial spraying was again employed successfully. In the 1946 campaign, 30.000 acres of crops and pasture were sprayed in addition to a large area treated with bait and in 1950, a relatively small outbreak in which 14.000 acres were sprayed. In the latter outbreak two Dakotas were hired from commercial airways. Each plane carried 700 gallons of spray solution which was applied at the rate of two gallons per acre, i.e. 350 acres per trip. If necessary they could travel 100 miles out from the aerodrome to carry out the spraying operation. The spray is emitted from two sets of spray bars, one under each wing. The spray solution consists of 1.3 % gamma isomer B.H.C. in diesel fuel oil plus Sovacide, an involatile highly aromatic petroleum fraction which will dissolve its own weight of B.H.C. The solution was pumped into the plane from a road-tanker. The plane could be loaded,

complete a spraying operation and return to the aerodrome in 30-35 minutes, if the treated area were within 30 miles of the aerodrome.

It has been suggested that small planes or else ground machines would be better for the purpose, but I do not agree. We are dealing with a mobile pest which, in the flying stage, can move rapidly and do considerable damage in a very short time. Speed of action is therefore essential. If either ground machines or small planes are used then numerous depots would have to be established throughout the threatened area otherwise movement of supplies could not be accomplished rapidly enough. Staff, trucks and equipment would be involved at these points and in some areas may not happen to be required, as the movement of swarms cannot be predicted. With large aircraft on the other hand two main depots were all that were required in Victoria, and any point within an area of 25,000 miles could be reached and treated within a few hours of the first report being received.

Permanent field officers stationed in the threatened area, belonging to either the Agricultural or Lands Department, sent in reports of swarm movements and acted as ground teams in their own localities. In the main areas two special ground teams with trucks and wireless were employed. Three or four in each team were sufficient.

The spraying procedures employed are fairly standard. The plane usually flies across wind at a height of 50 to 100 feet according to wind strength (H U 500). The speed of the plane is 160 m.p.h. and is guided along the correct course by smoke generators. These may indicate the starting and stopping point or, in the case of very long runs, may be spaced a few hundred yards apart to give line of flight while the length of the run is given to the pilot over the wireless. Flags can be used to replace smoke on open country, but smoke is always used to guide the plane to the point of action when it has been called to a new area from the aerodrome.

A swathe width of 88 yards is used but wider swathes and stronger solutions are under consideration. In strong winds flying head-on into the wind has been practised occasionally to reduce the width of the swathe.

B.H.C. has been found satisfactory because it is extremely effective against the locusts but has a low toxicity to mammals. Slowness of action is one of its chief disadvantages as insects with a low dose may fly considerable distances before dying and it is therefore difficult to obtain estimates of the mortality without a great deal of work.

One characteristic of B.H.C. which has both advantages and disadvantages is the effect of spray drift, too light to cause mortality, but which causes locusts to move out of the locality in which it occurs. This means that if it is desired to destroy a swarm the operation should be planned so as to be carried out in the minimum time possible and it is better to employ all forces at one place for this purpose rather than have a number of treatments going on at the same time in different localities. On the other hand it may happen that the scattering of a swarm without a high mortality would

be sufficient for the purpose. In this regard it must be remembered that in our circumstances we are not greatly concerned if small numbers survive a treatment as most seasons are unfavourable to the further reproduction of the pest within Victoria. Treatment of ovipositing swarms, which has not yet been tried out as a means of preventing an outbreak, would have to be approached with the object of getting the maximum mortality. It would appear to be worth while trying out such a measure rather than waiting for the eggs laid to be hatched. Swarms in flight have been sprayed with good results.

In both 1946 and 1950 the methods employed were successful in preventing any major damage to crops and pastures. In the last outbreak the cost of the aircraft was less than 5/- per acre, other costs including materials amounting to about 11/- per acre.

The campaigns have been based on the result of research work involving both laboratory insecticide tests and the study of droplet patterns of the spray dispersed from the aircraft. In the latter aspects the principal aspect of the work has been the behaviour of the droplets with a view to determining the optimum size, or mixture of sizes, which would give the most uniform distribution of spray over a swath of reasonable width. Slides coated with magnesium oxide have been used for the purpose.

DISCUSSION

Mr. **Jary**: At what speeds were the DC 3 and Beaufort flying?

Mr. **Hogan**: DC 3 at about 150 mph, Beaufort at about 180 mph.

Mr. **Smith**: What was the gallonage applied per acre in these tests?

Mr. **Hogan**: 2 gallons per acre.

Mr. **Smith**: Was it an oil or a water solution?

Mr. **Hogan**: Diesel fuel oil solution.

Mr. **McCauley**: What effect was noted on particle distribution where side winds were encountered?

Mr. **Hogan**: Most of the spraying was carried out across wind and the problem has been to produce a spray with a drop spectrum such that an even distribution of spray will be obtained when carried by the wind from a given height.

Mr. **Maan**: How is the contact established between the pilot and the field-markers especially in the case of changing wind-conditions?

Mr. **Hogan**: Radio is the only completely satisfactory method and this was used where the greatest infestations occured. Smoke generators, flags and a code of signál were used to communicate with the pilot in other circumstances.

CONTROL OF TSETSE FLY (Glossina Palpalis) WITH A NEW TYPE OF DDT SUSPENSION

by
N. van TIEL
Amsterdam, The Netherlands

Summary *).

It is generally known that the effectiveness of an insecticidal toxicant is greatly affected by the way it is formulated. Factors as rain-resistance, stability towards sunlight, penetration into permeable surfaces, crystal size of the toxicant, etc. largely depend on the form in which the insecticide is applied.

The present investigation is a contribution to the solution of some problems encountered in the control of *Glossina palpalis* R.-D., as far as ground spraying on vegetation with DDT-containing products is concerned.

In general there are three forms in which DDT can be applied into vegetation: as straight solution, as wettable powder and as emulsion.

Spraying of straight solutions was handicapped by penetration of active material into the leaf surface (SYMES et al. 1947). Wettable powders showed a lack of rain resistance and stability towards sunlight. So far, emulsions had given the best results.

Experiments have now been made with a new type of DDT suspension, which is in its concentrated form a 50% DDT containing, thin, creamy paste, easily pourable and dilutable with water. It consists of fine DDT crystals suspended in the water phase of a mineral oil emulsion. When diluted it gives a more stable suspension than wettable powders. Residues are highly toxic owing to small particle size and absence of inert filler material.

Two islands in Lake Victoria (Uganda) were selected for field experiments. One (Makusu) was sprayed with the new suspension (called "Supona"-D**)), another (Mbirubuziba) was treated with a DDT emulsion. 5% DDT containing dilutions were used. Two other areas were left untreated for control. Sprayings were selective, i.e. only those parts of the islands were treated where *Glossina* lived by preference, viz. vegetation along paths, along the coast and the vegetation bordering on open spaces. The total area sprayed amounted to about 5-10% of the entire island.

On Mbirubuziba (DDT emulsion) there was an immediate reduction to 22% of the original fly population, which was maintained for 17 weeks after the last spraying. Then, coinciding with a period of heavy rains, a marked in-

*) Read by J.W.Heringa (Amsterdam, The Netherlands). The complete article will be published in the Bull. of Entom. Res. 1952.

**) "Supona" is a trade mark of certain companies of the Royal Dutch/Shell Group. D is used to indicate that the insecticide concerned is a suspension containing DDT.

crease was noticeable, till 35 weeks after the last spraying the original population had recovered completely.

On Makusu ("Supona"-D) there was also an immediate reduction to 22% of the original population. A fortnight after the last spraying, however, the population decreased further to 3% of the prespraying number, which means a reduction of 97%. Until 36 weeks after the last spraying there was only a very slight upward tendency. Then a more definite continuous increase set in, reaching a level of 39% of the prespraying value 51 weeks after the last spraying.

Chemical analysis of leaf samples 4 weeks after spraying showed equal DDT residues on both islands, but 22 weeks after spraying there was no DDT detectable in Mbirubuziba (DDT emulsion), but still slight amounts in Makusu ("Supona"-D).

The results showed a better persistency under field conditions of the "Supona"- D as compared with the DDT emulsion used. This may be a valuable contribution to the improvement of tsetse fly control.

Literature:

SYMES, C.B., A.B.HADAWAY, F.BARLOW and W.GALLEY - Bull. Entom. Res. 38: 591, 1947.

DISCUSSION

Mr. **Ketelaar**, Amsterdam (Netherlands): What was the concentration of the spraying solutions and what was the amount used per acre?

Mr. **Heringa**: 5% DDT containing sprays were used at abt. 5 to 6 lbs per acre.

Mr. **Wilson**, Kenya (Br.East Africa) describes spraying of the vegetation along a river. The river was 16 miles long and in parts heavily infected with *Glossina palpalis*. A 50 percent DDT paste was used, applied by knapsack sprayers at 5 percent solution. DDT was applied at the rate of 10 to 15 lbs per acre. Applications were at 3 week intervals. The conclusions were:

1. A marked reduction of 90 to 95% in the *Glossina* was noted after the first application.
2. A residual effect was noted up to 2 weeks.
3. Spraying must be sustained over a period - probably over 6 months.
4. Heavy rains following spraying had a marked deleterious effect.
5. Isolation of the area sprayed is essential.
6. In early spraying DDT was applied to fringing vegetation along the whole river stretch. After the 4th spraying only selected portions were sprayed. The amount of DDT applied was reduced from 210 lbs to 10 lbs per application.

Mr. **Reid**, Kuala Lumpur (Malaya) asked Dr. WILSON: What formulation of DDT was used?

Mr. **Wilson**: DeDeTane paste. Latterly a 15% emulsion.

Mr. **Burt**, Harpenden (England): Have any experiments been carried out to determine if absorption by foliage is responsible for loss of DDT?

Mr. **Heringa**: From solutions absorption of DDT can take place to a marked extent but much less from emulsions and suspensions.

A GRAPHICAL CALCULATOR FOR STATISTICAL ANALYSIS OF EXPERIMENTS IN ENTOMOLOGY

by

Jean DUFRENOY and James L. PLUMB
San Francisco, U.S.A.

The Usefulness of Graphical Methods.

Many, who spend so much time performing experiments are deterred fro obtaining therefrom all available results, because it is generally believe that statistical methods apply only to experiments involving "large nun bers", and also because mathematical statistics involve computations whic are laborious unless the experimenter routinely uses computing machines

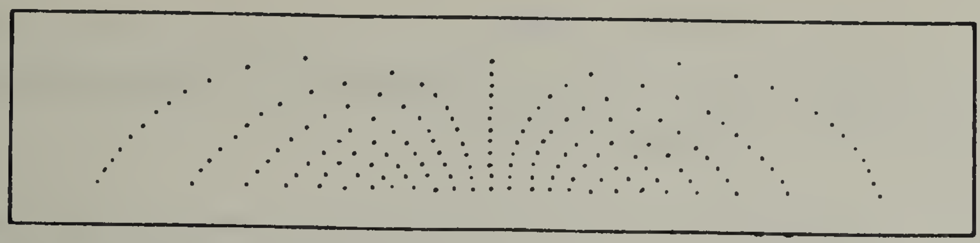
Those two obstacles to statistical analysis may be removed by graphica methods, using scales of coordinates whereby the distribution function to b studied is represented by a straight line: inasmuch as 3 points are enoug to define a straight line, 3 experimental results are theoretically enough t define the population in terms of the mean and standard deviation; grantin that 3 points may not afford enough data to test the rectillinearity of th regression line on the graph, we may at least claim that for practical pu poses 5 determinations suffice to give the experimental data whereby tox icological or other such experiments on insects can be made amenable t statistical analysis with graphical methods.

Application of Graphical Methods to Toxicological Assays.

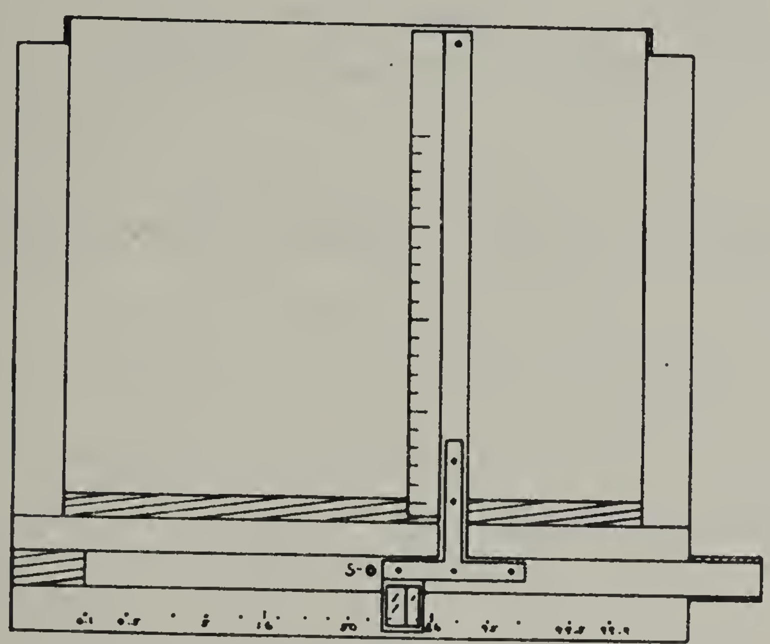
It may be recalled that, as defined by the Official Specification of th Chemical Specialities Manufacturers Association for Insecticides and Dis infectants, in U.S.A., the "Peet-Grady Small Group Method" calls for th use of "5 pairs of lots of 100 flies"; one lot of each pair being submitte comparatively to one of the two insecticides: (I) the "standard preparation or (A) the "insecticide to be assayed"; there is thus obtained 5 experimenta differences (x) each corresponding to the difference of toxic effects of (A as compared to (I); the test for significance may be carried conventionall as prescribed for the Peet-Grady test, or more accurately still by using th classical "t test" as devised by R.A.FISHER. Faster and at least as accurat an analysis may be obtained simply by arranging serially the 5 values of in ascending order of magnitude, and using the graphical calculator, devise and described by F.M.GOYAN and J.DUFRENOY, plot each successive valu of x in ordinate at its rank on the abscissa scale of "normal probability" that is to say, respectively at 10, 30, 50, 70 and 90.

Automatic Device of the Graphical Calculator.

Whichever the numerical values of (x) each of these 5 values being con sidered as 5 samples drawn at random from a "normal distribution" should when plotted at his rank, 10, 30, 50, 70 or 90, and at the appropriate ord inate, line up on a straight line. The positions 10, 30, 50, 70 and 90, bein



Pattern of holes drilled in template which, with the pin "S" shown on the drawing below, makes up the device for automatic plotting mentioned in the text.



Top view of graphical calculator

defined on the normal probability scale by the number of the (x) which is 5, it is possible to locate those positions at 5 holes wherin a plunger will fall when the slide rule carrying the ordinate scale is moved along a groove corresponding to 5; the device carrying "groove 5" may carry as many grooves as may be convenient, corresponding to as many numbers of samples from a population, from 3 upwards and that device may slide (or roll) so as to line up the proper groove into the pathway of the plunger carried by the slide-rule. Plotting is thus made automatic.

Choice of Ordinates

In the graphical calculator as devised, the abscissa scale is always the "normal probability" scale, appropriate fixed positions of which referring to any set of data from 3 to about 25 are materially defined by holes punched in the automatic device.

Where the numerical values to be plotted may be considered as randomly obtained from a "normal population" the scale of ordinates to be used is an arithmetic scale.

Example: Determine the mean and standard deviation for the 5 differences; 0, 3, 6, 8, each representing the difference of percent mortality caused by the standard insecticide or by the insecticide to be assayed according to the Peet-Grady test.

The 5 values, successively plotted at their rank 10, 30, 50, 70 and 90 with the automatic device along "groove 5" line up along a straight line which intercepts the ordinate drawn from rank 50 at an ordinate 4.8 and the

ordinates drawn from rank 16 and 84 (defining the range $\pm$SIGMA at distances $\pm$ 3 from the position 4.8 on the scale of ordinates. Therefore the mean and standard deviation are $4.8 \pm \frac{3}{\sqrt{5}}$ or 4.8 ± 1.4.

In many experiments dealing with insecticides, however, the responses are distributed not as from a normal distribution, but as from a log-normal distribution in respect to the dosage applied; in other terms, the population is normally distributed as to the log of the dosages applied.

The graphical calculator can be fitted with any scale of ordinates, whether logarithmic, or in units of probits to fit various needs.

Literature

DUFRENOY, J. and Frank M. GOYAN - J. Am. Pharm. Assn., 36:309-14, 1947.

USE OF ALDRIN AND DIELDRIN IN SOIL WIDENS SCOPE OF PEST CONTROL

by

C.C.COMPTON & W.E.McCAULEY,
Denver, Colorado, U.S.A.

Summary *).

The insect toxicants "ALDRIN" (Compound 118) and "DIELDRIN" (Compound 497), synthesized in 1948, were first evaluated for effectiveness on such pests as grasshoppers and several other free-living pests. First to be tested, "ALDRIN" proved effective at dosages of 2 to 4 ounces per acre for such pests as grasshoppers and boll weevil. Following officials recommendation for its use, commercial development of "ALDRIN" has been rapid (approximately 3 million pounds in 1950 and an anticipated use of 7 million pounds in 1951). "DIELDRIN", although more efficient than "ALDRIN" on a weight basis, is much less volatile and is better suited for situations where persistence of residue is desirable; nonetheless, its commercial development has been less rapid (production through 1951 season is estimated at approximately 1 million pounds).

The success of "ALDRIN" against such pests as grasshoppers led naturally to extensive evaluation of both products against insects in the soil. Most surprising result of these tests has been the indication that "ALDRIN" persists as well in the soil as does "DIELDRIN". Also very encouraging is the fact that neither product has imparted off-flavor to produce grown in treated soil; furthermore, no evidence of translocation or absorption of either product by root crops has been found.

The outstanding accomplishment of subterranean pest control has now opened a new field of research, i.e., the evaluation of "pre-emergence" application. Since most above-ground insect damage stems from insects which spend a portion of their life in the soil, it is logical that they too can be destroyed by soil application. The extended contact between insect and chemical (present in the soil) inherent in this method yields maximum effect at remarkably low dosages, which contributes to both economy and safety.

As little as one or two parts per million of ALDRIN in the soil is effective for the destruction of most of the important subterranean insects. Non-insects such as symphillids and earthworms are more resistant and require much higher quantities of chemical.

Current practices for applying insecticides to the soil make use of such standard farm operations as (1) irrigation, (2) fertilization, (3) seeding, and (4) watering at transplant time. Special procedures for applying chemicals to soil involve spraying or dusting usually ahead of tilling to insure some distribution through the soil.

*) An extensive article (21 pages) under the same title has been published by Mr. W.F.McCauly Entomologist, Julius Hijman & Company, Denver, Colorado, and was presented at the session to those interested.

SECTION XIV

ARACHNOIDEA

DAS WACHSTUM UND DIE HÄUTUNG VON TEGENARIA AGRESTIS (ARANEAE)

von

Heinrich HOMANN
Göttingen, Deutschland

Die Häutung der Spinnen ist bisher von mehreren Biologen untersucht; die Vorgänge sind von ihnen gut beschrieben, deren Deutung aber ist wenig überzeugend. Erst experimentelle Eingriffe gaben Klarheit über die wirksamen Kräfte.

Die Häutungen hängen eng mit dem Wachstum der Spinnen zusammen, so dass dieses bei der Untersuchung nicht vernachlässigt werden darf. Darauf deuten schon die Proportionen der Körperteile vor und nach der Häutung hin. Unmittelbar vor der Häutung ist nämlich das Abdomen dick, während der Häutung schrumpft dieses zusammen, und dafür scheinen der Cephalothorax und die Beine gewachsen zu sein. In dieser kurzen Zeit ist ein „Wachstum" nur durch Stoffverlagerung und nicht durch Stoffvermehrung möglich. Wägungen der Spinnen, getrennt nach den Körperteilen, ergaben folgendes Resultat. Zwischen den Häutungen wächst nur das Abdomen, nur vor der 1. und 2. Häutung kann auch der Cephalothorax zunehmen. Hat sich das Gewicht der Spinne verdoppelt, so tritt die Häutung ein. Dabei wird Stoff in Form von Blut (Haemolymphe) vom Abdomen in den Cephalothorax und die Beine gepumpt, die auf diese

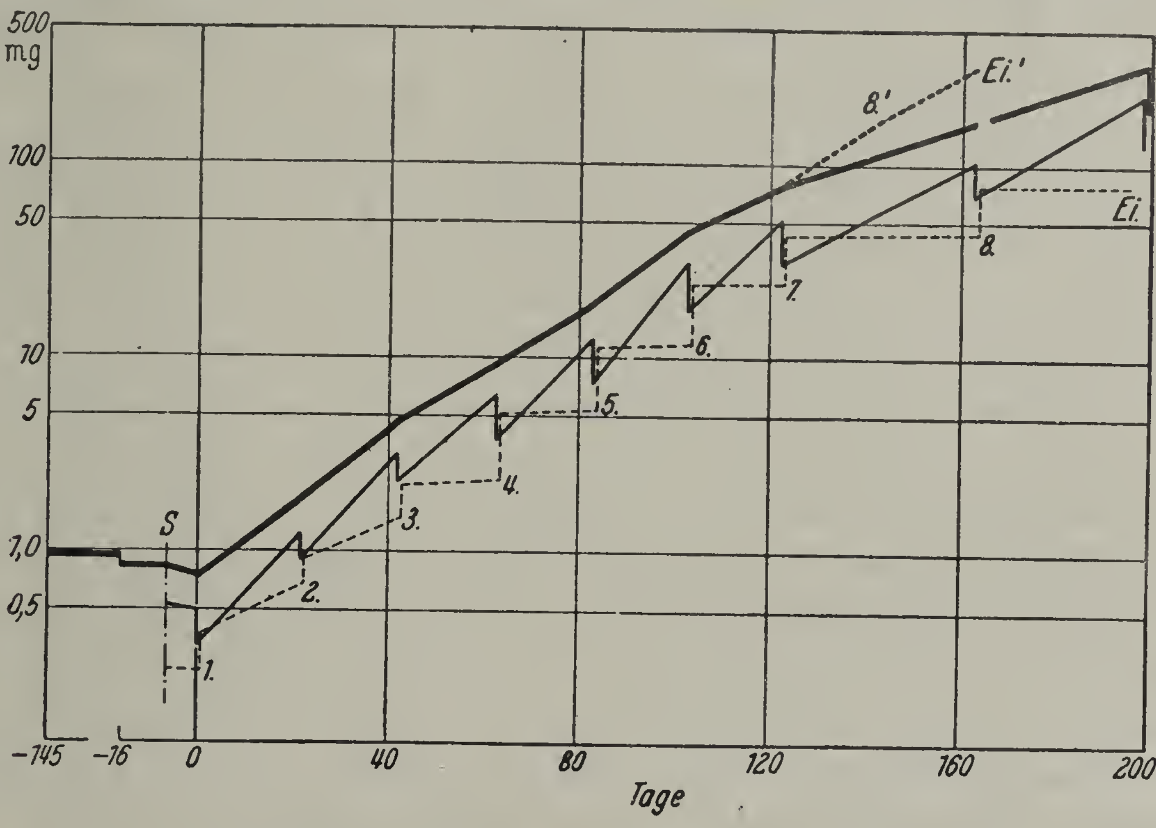


Fig. 1 — Wachstumskurve von Tegenaria agrestis. Starke Linie = Gesamtwachstum, schwache Linie = Wachstum des Abdomens, Gestrichelte Linie = Grössenzunahme des Cephalothorax. Als O-Punkt ist der Tag der Häutung gewählt, durch den die Spinne komplett wird. Tag −145: Ablage der Eier, −16: erste Wägung. S = Datum des Schlüpfens, Ei = Datum der Eiablage nach der Reifungshäutung. Die Ordinate ist logarithmisch geteilt. Bringt man die letzten Abstände auf den gleichen Zeitraum, so ergibt sich die gestrichelte Linie.

Weise grösser werden. Das Gesamtwachstum folgt der Formel $g = a.2^t$, wobei g das Gewicht der Spinne, a das Anfangsgewicht und t die Anzahl der Häutungen angibt. Bei einer Häutung nimmt das Gewicht des Abdomens durchschnittlich auf 67% ab, während der Cephalothorax und die Beine auf 180% zunehmen. Als Waage diente ein Feiner Glasfaden, dessen Durchbiegung mikroskopisch abgelesen wurde.

Für die Häutung ergeben sich besonders 3 Probleme. 1. Wie gross ist der Druck zum Sprengen der Cuticula? 2. Wie wird dieser Druck erreicht? 3. Wie werden die Beine befreit?

Durch Wägung des in der Zeiteinheit aus dem abgeschnittenen Bein einer Spinne heraustretenden Blutes (Grössenordnung etwa 1 mg/min) lässt sich vergleichsweise auf den Druck schliessen. Die Menge des Blutes war bei dem gleichen Tier zwischen den Häutungen 0.7 mg, beim Einsetzen der Häutung 1.35 mg. Das zeigt eine Verdoppelung des Blutdruckes bei der Häutung an. Zur absoluten Messung des Blutdruckes wurde ein abgeschnittenes Bein in eine Glaskapillare geklebt. Diese war durch ein Stück starken Gummischlauches mit einer zweiten Kapillare verbunden, in der durch Veränderung eines abgeschlossenen Luftvolumens der Druck zu messen war. Durch Zusammenquetschen des Schlauches konnte der Druck auf etwa 0.2 atü gesteigert werden. Bei dem Abschneiden des Beines tritt dann ebenfalls Blut heraus. Durch Vergleich dieser Blutmenge bei bekanntem Druck mit den Blutmengen in den eben erwähnten Versuchen ergab sich der wirkliche Druck zwischen den Häutungen zu 0.18 atü, während der Häutung zu 0.35 atü. Der Blutdruck zwischen den Häutungen hat etwa die gleiche Grösse wie bei dem Menschen.

Diese Werte wurden durch weitere Beobachtungen bestätigt. Betrachtet man die Exuvie der Spinne als einen Kessel, der durch Druck gesprengt werden soll, so lässt sich dieser Druck berechnen, wenn man den Durchmesser des Kessels, in diesem Falle der Exuvie, die Dicke seiner Wand und die Zerreissfestigkeit des Chitins kennt. Die Dicke der Haut kann an Schnitten gemessen werden, der Durchmesser ebenfalls an Schnitten oder über den Umfang durch Herumlegen eines Fadens um den Cephalothorax; die Zerreissfestigkeit des Chitins musste durch Zerreissversuche an den Beinen ermittelt werden, wobei in diesem Falle nur die dünne Haut an der Beugeseite der Gelenke berücksichtigt wurde. Die Festigkeit ergab sich zu 270 kg cm^{-1}; sie ist der Grössenordnung nach gleich der Zerreissfestigkeit der sog. Kunststoffe. Das Einsetzen dieser Werte in die zum Sprengen eines Kessels gültige Formel ergab einen Druck von 0.8 – 1.0 atü bei verschiedenen Versuchen. ($\sigma\ max = p.r.s.\ kg.\ cm^{-1}$, wenn $\sigma\ max$ = Zugspannung im Moment des Reissens, p = Druck, r = Radius und s = Wandstärke des Kessels, in diesem Falle der Exuvie, ist.) Hierbei muss aber noch berücksichtigt werden, dass das Chitin durch innere Auflösungsvorgänge für die Häutung geschwächt wird. Um diese Zahl zu ermitteln, wurden den Spinnen zwischen den Häutungen je 2 Beine unter Messung der Belastung abgerissen, und zwar an dem für die Autotomie praeformierten Gelenk. Den gleichen Tieren wurden beim Einsetzen der Häutung die übrigen Beine abgerissen. Dazu war nur noch 1/3 der vor-

her angewandten Kraft nötig; es ist also bei diesem Zustande des Chitins zum Sprengen nur 1/3 des oben errechneten Druckes erforderlich, etwa 0.3 atü.

Auch schon allein über die Kräfte, die zum Abreissen eines Beines nötig sind, kann man den Druck errechnen. Denkt man sich die Zugkraft zum Abreissen ersetzt durch eine Drucksteigerung im Innern der Spinne, so ergibt sich aus dem Durchmesser des Beines das Mass für den äquivalenten Druck. Die Rechnung führte auf einen Wert von 0.28 atü.

Schliesslich wurden Spinnen, die zur Häutung bereit waren, in narkotisiertem Zustande von einem Bein aus mit Wasser aufgeblasen, bis die Exuvie einriss. Das hierzu benutzte Gerät liess wiederum durch ein abgeschlossenes Luftvolumen den Druck messen. Beim Herunterdrücken der Cheliceren, einer Bewegung, die auch an dem sich häutendem Tiere beobachtet wurde und die eine zusätzliche Spannung in der Exuvie unterhalb des Clypeus erzielt, sprang die Haut an dieser Stelle bei einem Druck von 0.35–0.4 atü.

Alle diese Versuche führen auf einen Druck von etwa 0.18 atü zwischen den Häutungen und etwa 0.35 atü während der Häutung. Diese Drucksteigerung ist im Körper leicht zu erreichen durch eine Vergrösserung der Schlagfrequenz und des Schlagvolumen des Herzens. Darauf deutet die gesteigerte Herztätigkeit bei der Häutung hin. Die Abdominalmuskeln hindern hierbei wahrscheinlich ein Zurückströmen des Blutes durch Verengung des Abdomens; doch lässt sich dieser Vorgang im Versuch kaum prüfen.

Das Befreien der Beine geht in 4 Phasen vor sich. Zuerst quellen die Beine durch den gesteigerten Druck im Cephalothorax aus der Exuvie heraus. Sind sie bis zu den Anfängen der Femora frei geworden, so werden sie durch Muskelkräfte weiterbewegt. (2. Phase) Zwei Beine einer Seite bilden ein Widerlager, und gegen dieses Widerlager werden die beiden anderen Beine herausgezogen. Diese Tätigkeit wechselt ab zwischen den 1. und 4. und zwischen den 2. und 3. Beinen, ebenfalls wechselweise auch zwischen den beiden Seiten. Diese Art der Befreiung ist nur möglich, solange die freien Stükke der Beine nicht zu lang sind, etwa bis zur Patella. Dann ist nämlich der Spielraum zum Herausziehen nicht mehr lang genug. Hier setzt die dritte Phase ein. Die Beugemuskeln der Beine werden angespannt. Da aber die Gelenke der Beine nicht mehr mit den Gelenken der Exuvie übereinstimmen, kann keine Beugung erfolgen, sondern eine Verkürzung des Beines. Diese Verkürzung lässt sich am Tier selbst beobachten, wenn es unmittelbar nach der Häutung an einem Bein aufgehängt wird. Eine Beugung des noch ganz weichen Beines wird in diesem Falle durch das Gewicht des Tieres verhindert. Die Verkürzung betrug bis zum 0.25 mm. Wenn nun das Bein bei der Häutung in der Exuvie verkürzt wird, kann es sich wegen der distalwärts gerichteten Behaarung nur körperwärts (proximal) bewegen. Auch durch Strecken des Beines infolge des Einströmens von Blut lässt sich diese Bewegung nicht rückgängig machen; im Gegenteil, auch bei dieser Streckung wandert das Bein in der gleichen Richtung weiter. Dieses ruckweise Weiterwandern durch das Spiel der Beinmuskeln lässt sich unter dem Mikroskop an der Kralle leicht verfolgen. Für die Be-

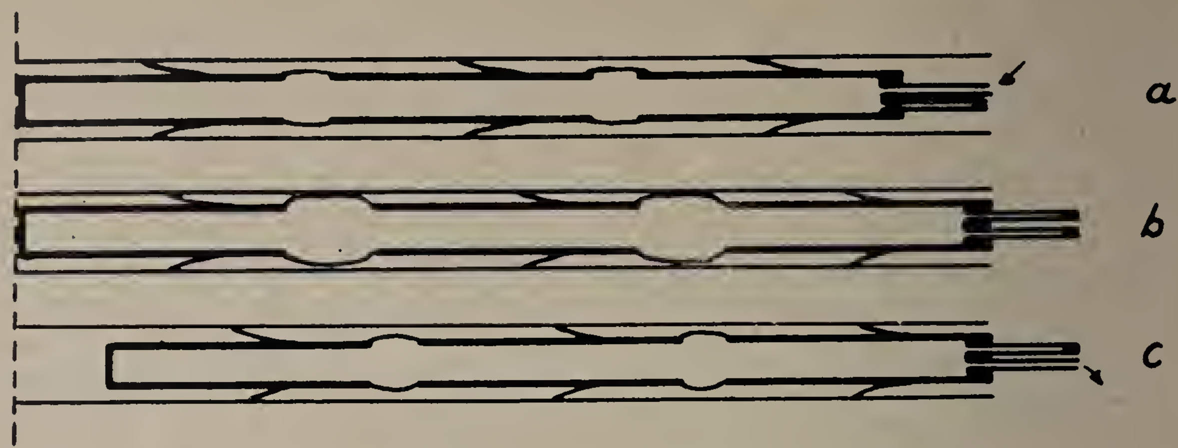


Fig. 2 — Modell zur Befreiung der Beine. Holzrohre mit aufgenagelten Uhrfedern (starke Linie) sind durch Stücke Fahrrad-schlauch verbunden. Bei b ist Luft eingeblasen; die Gummistücke haben sich verlängert. Wegen der nach links sperrenden Federn bewegen sich die Holzrohre nach rechts. Bei c ist die Luft herausgelassen, die Holzstücke können den sich verkürzenden Gummischläuchen wiederum nur nach rechts folgen.

freiung der Beine in dieser 3. Phase ist also die Richtung der Behaarung von ausschlaggebender Bedeutung. Dieser Vorgang lässt sich modellmässig nachahmen. Kurze Holzröhren, an denen als Ersatz für die Behaarung Stücke von Uhrfedern befestigt sind, werden durch kurze Stücke Gummischlauch (vom Fahrrad) verbunden. Zwei Zuführungen zum Einblasen und zum Ablassen von Luft sind vorhanden. In ein festes Rohr von Papier eingewickelt, findet bei dem Aufblasen mit Luft durch die Dehnung nur eine Verlängerung der Gummischläuche statt; die Richtung dieser Verlängerung ist durch die Uhrfederstücke gegeben. Wechselt man nun den Druck abwechselnd von einem Maximum zu einem Minimum, dann rutscht das Modell des „Beines" *ohne Einwirkung äusserer Kräfte von einem Stützpunkt aus* aus dem Rohr, der „Exuvie", heraus. Zu weiterem Vergleich wurden die Beine mit gemessenen Kräften aus der Exuvie der Spinne herausgezogen, nachdem diese an den Coxen durchschnitten war. Es waren auf diese Weise nur die Reibungskräfte innerhalb der Exuvie zu überwinden. Die Kräfte hierbei waren nicht grösser als die, die eine Spinne durch Heben angehängter Gewichte überwinden konnte. In der letzten 4. Phase endlich helfen die schon befreiten Beine die anderen, die noch in der Exuvie stecken, aus dieser herauszuziehen.

Das Freiwerden des Abdomens aus der Exuvie bietet keine besonderen Probleme. Es reisst an den Seiten bei der Häutung auf, und dabei schrumpft es gewaltig infolge der Blutabgabe an den Cephalothorax und die Beine. So wird das Abdomen gewissermassen von selbst aus der Exuvie frei.

Eine ausführliche Darstellung findet sich in: Zeits.vergl. Physiol, Vol. 31, 1949.

DISCUSSION

Mr. **Van Eyndhoven:** Macht es Unterschied um welche Art es sich handelt? *Pholcus* z.B. hat sehr lange Beinglieder.

Mr. **Homann:** Das ist nicht der Fall.

Mr. **Van Eyndhoven:** Ich möchte noch bemerken, dass die Milben es oft anders machen. Es kommt z.B. vor, dass die Beine nicht aus der Exuvie gezogen werden, sondern das ganze neue Tier schon ganz fertig mit seinen 8 Beinen im Soma der vorhergehenden Phase liegt.

ON THE SPIDER FAUNA OF NEWFOUNDLAND

by
Walter HACKMAN
Helsingfors, Finland

During the summer 1949 a Finnish-Swedish biological expedition collected a large material of insects, spiders and other arthropods in Newfoundland, a country where these groups of animals have been very little studied before. The expedition was supported by the Arctic Institute of North America and the chief purpose was to compare the Newfoundlandian fauna with that of North Europe. The material of the expedition has been worked on by Finnish and Swedish specialists and the true spiders were handed to me. Most of the spiders in the material had been collected by Dr Ernst PALMÉN (Finland) but also some lots by Prof. Dr Carl H. LINDROTH (Sweden). I have now identified most of the species and in this work Dr Willis J. GERTSCH (U.S.A.) and other American arachnologists have given me a good help by sending me literature and material for comparison. Of course there are still some taxonomical problems to be solved in this material and some determinations to be controlled, but the present results allow already a general survey of the spider fauna.

The total number of species is about 210. All species belong to the subdivision Labidognatha. The number of species in the different families is shown in the table. In this table I have also put the corresponding numbers for the New England Region (U.S.A., vide KASTON 1948). Torne Träsk Region (Swedish Lapland, HOLM 1950) and Finland.

Most of the species from Newfoundland occur also in the New England Region of the U.S.A.. but there are some true arctic species not found in the latter region. Unfortunately the spider fauna of the adjascent parts of Canada, namely Nowa Scotia and Labrador has been very little studied. Among the species not yet identified there are at least two Erigonidae new for science. I think, however, that they could be found also in other parts of arctic North America, because one could hardly expect any endemic species in Newfoundland. The number of species common to Europe is surprisingly high, about 24% of the total number. Two Erigonidae, *Trachynella nudipalpis* Westr. and *Cornicularia unicornis* Cambr. are new to the Nearctic Region.

Among the spiders from Newfoundland there are several close vicariants to North European species. In some cases the differences are very slight and one could rather suppose that the Northeast American and the European species in fact are end links of a chain of subspecies. *Hypomma marxi* Keys. and *H. bituberculata* Wid. may serve as an example. It may be pointed out that there is still much work to be done, before the principles of "the new systematics" can be applied on the spider taxonomy. In the family Erigonidae there is also much to do to link together the American and European generic system.

Table I — Number of species in the different families

	Newfoundland	New England	N Seden Torneträsk Reg.	Finland
Atypidae	–	1	–	–
Oonopidae	–	2	–	–
Dysderidae	–	1	–	–
Segestridae	–	1	–	1
Scytodidae	–	1	–	–
Pholcidae	–	2	–	–
Therididae	13	56	7	31
Nesticidae	1	2	–	1
Linyphiidae	36	50	35	53
Erigonidae	± 60	144	73	± 100
Epeiridae	13	47	8	28
Theridiosomatidae	1	1	–	–
Tetragnathidae	6	14	1	8
Mimetidae	–	5	–	2
Agelenidae	3	19	1	3
Argyronetidae	–	–	1	1
Hahniidae	4	5	1	4
Pisauridae	3	9	–	1
Lycosidae	22	50	15	46
Oxyopidae	–	2	–	1
Gnaphosidae	7	38	9	31
Clubionidae	10	50	3	31
Anyphaenidae	–	6	–	1
Ctenidae	–	1	1	3
Sparassidae	–	–	–	1
Thomisidae	9	27	5	21
Philodromidae	4	17	3	13
Salticidae	10	61	2	34
Oecobiidae	–	1	–	–
Dictynidae	3	22	6	7
Uloboridae	–	2	–	–
Amaurobiidae	4	6	1	2
Hypochilidae	–	1	–	–

Most of the species common to Europe and Newfoundland are occurring in Fennoscandia and nearly half of them could be placed in arctic or boreal categories of distribution. There is, however, a group of species showing a strange type of distribution:

Crustulina sticta Cambr.
Theridula opulenta Walck.
Theridiosoma gemmosum L.Koch
Epeira displicata Hentz
Philodromus rufus Walck

These species have a large distribution in Eastern America, Georgia to Newfoundland, but here in Europe they are not found in boreal areas. The northernmost find of *Philodromus rufus* is in Skåne in Sweden, *Crustulina sticta* in England, *Theridula opulenta* in France, *Theridiosoma gemmosum* in South Germany and *Epeira displicata* in Holland.

Among the spiders with a wide holarctic distribution, following species in the Newfoundland material might be signed as more or less synanthropic:

Steatoda bipunctata L.	*Epeira cornuta* Cl.
Lepthyphantes leprosus Ohlert	*Epeira sericata* Cl.
Diplocephalus cristatus Bl.	*Micaria pulicaria* Sund.
Meta meardi Latr.	*Zelotes subterraneus* C.L.Koch
Zygiella montana C.L.Koch	*Salticus scenicus* L.

It is very probable that a great many species of spiders have invaded Newfoundland in postglacial times from South West. Erigonids and also many other spiders are known as good aeronauts and the open sea between Cape Ray of Newfoundland and the Cape Breton Island of Nova Scotia may hardly be any hindrance for the ballooning flight.

Though the material consists of more than 300 samples taken in very different parts of Newfoundland, the maps of finds do not show much of significance except in very few cases. More than one summers collecting is needed before one could get a true picture of the distribution of the spiders within Newfoundland. I have not yet seen the material collected there in this summer, 1951, by Prof. Dr LINDROTH, but I think it will be a good completion to the former material.

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LES ARAIGNEES DANGEREUSES DANS L'AMERIQUE DU SUD

par
Jehan VELLARD
Lima, Perú

Les accidents graves, causés par des araignées de diverses familles, ne sont pas rares en Amérique du Sud et une abondante bibliographie, augmentant chaque année, leur a été consacrée. On les observe aussi bien dans les régions tropicales que dans les contrées tempérées du Continent. Ce problème de l'aranéisme est assez important pour justifier la préparation par l'Institut brésilien de Butantan à São Paulo de divers types de sérum thérapeutique contre le venin des principales araignées dangéreuses du Brésil. Un sérum contre le venin de *Latrodectus mactans* Fabr. a été obtenu à l'Institut Bactériologique Carlos Malbran de Buenos Aires.

Les espèces sud-américaines réellement dangéreuses sont cependant peu nombreuses. Quelques unes seulement réunissent les conditions nécessaires: venin très actif pour les vertébrés, quantité suffisante de venin et genre de vie les mettant en contact fréquent avec l'homme.

Types de venin

Les venins d'araignée sont bien moins complexes que ceux des serpents. La plupart d'entre elles ne sont vraiment dangereuses que pour les petits arthropodes dont elles se nourissent habituellement et l'effet de leur venin sur les vertébrés est faible.

Quelques venins se sont différenciés montrant une activité très élevée pour un groupe particulier d'animaux, poissons, reptiles ou autres.

Parmi les araignées sud-américaines possèdant un venin doué d'action élective sur certains groupes de vertébrés les exemples suivants sont particulièrement démonstratifs:

Les grandes *Trechalea, T.longitarsis, T.keyserlingi,* paralysent rapidement les têtards et les poissons de petite taille. *Enoplectenus germaini,* fréquent dans la forêt littorale du Brésil entre Espiritu Santo et São Paulo sur les troncs d'arbres, les parois rocheuses et à l'entrée des grottes chasse au début de la nuit de gros insectes et surtout des geckos; ce venin possède une très grande activité pour ces derniers et en général pour tous les lézards. Plus intéressant encore est le cas d'un groupe de mygales, les *Grammostola* dont le venin, peu dangereux pour les autres vertébrés, possède une action élective très élevée sur les lézards ou les petits serpents, venimeux ou non, que ces araignées rencontrent fréquemment au cours de leurs chasses nocturnes. 0.10 milligramme de venin de *G.acteon* suffit pour paralyser et tuer rapidement un petit serpent à sonnettes de 30–40 cm de longueur. Le venin de *Latrodectus mactans* est particulièrement dangereux pour les scorpions, *Bothriurus* et *Tytius* vivant dans les mêmes régions que cette araignée et dont les restes sont fréquemment dans ses toiles.

Il s'agit dans tous ces cas d'une exaltation de venin propre à tout un groupe d'araignées pour des proies habituelles ou tout au moins fréquentes. C'est un mécanisme analogue à celui qui s'observe chez les serpents ophiophages ou ichthyophages. Il est par contre difficile d'expliquer l'activité élevée du venin d'autres groupes d'araignées, par exemple de la grande *Trechona venosa*, espèce terricole, pour les oiseaux (0.001 mgr. par voie veineuse suffit pour tuer un pigeon) ou des *Ctenus* pour les mammifères. La morsure d'un *Ct. ferus* ou *Ct. nigriventer* tue une souris en moins de deux minutes.

Un très petit nombre d'araignées sud-américaines possèdent un venin très actif pour les mammifères, capable de provoquer chez l'homme des accidents graves ou mortels.

J'ai proposé de classer ces venins dangereux en trois groupes principaux:

Les venins neurotropes, type *Ctenus, Trechona* et *Latrodectus.*

Les venins nécrosants purs, type *Lycosa.*

Les venins mixtes nécrosants et toxiques provoquant en plus des lésions locales étendues, des manifestations graves nerveuses, hépatiques ou rénales.

Tous les venins d'araignées sont primitivement des venins mixtes provoquant à la fois une réaction locale plus ou moins étendue et des symptômes généraux. A ce type appartiennent la majorité des venins aranéiques, peu dangereux pour l'homme, ne produisant qu'une petite douleur passagère et une réaction locale peu intense.

Lorsque les venins montrent une exaltation globale de leur activité ils produisent le type d'accidents mixtes observés après les morsures de *Theraphosinae,* de *Loxosceles,* de *Segestria* et autres.

D'autres venins, au contraire, ont perdu une partie de leur activité citotoxique mais leur action neurotrope s'est élevée réalisant le type d'aranéisme produit par *Latrodectus,* dont le venin allie un fort effet neurotoxique à des lésions tardives de néphrite pouvant entraîner la mort. Un degré plus élevé est réalisé par le venin de *Ctenus,* presque exclusivement neurotrope qui provoque des contractures toniques pouvant aller jusqu'à l'opisthotonus et aux convulsions généralisées sans la moindre réaction locale.

La spécialisation du venin peut au contraire s'exercer dans un sens différent: les propriétés neurotoxiques et toxiques générales disparaissent, mais l'activité nécrosante locale devient extrêmement puissante produisant de vastes nécroses cutanées.

L'activité du venin n'est qu'un des facteurs contribuant à rendre les araignées dangereuses. Même parmi les espèces sud-américaines potentiellement dangereuses pour l'homme un petit nombre seulement occasionne des accidents.

Aucun cas de morsure n'a jamais été attribué à la grande *Trechona venosa* qui vit dans de profonds terriers dans la forêt littorale du Brésil. Dans bien des régions les accidents dus aux *Ctenus* sont inconnus même quand ces araignées n'y sont pas rares. Ailleurs, au contraire, dans les plantations de bananiers du Brésil par exemple, les *Ctenus* vivent sous les feuilles mortes ou dans les régimes de fruits et les accidents sont fréquents chez les tra-

vailleurs. On les observe même chez les débardeurs des ports d'embarquement ou des ports de destination. L'assistence publique de Buenos Aires a demandé, il y a quelques années, du sérum antictenus à l'Institut de Butantan pour traiter ces accidents. Plusieurs cas de morsures ont été observés en Europe en particulier à Anvers. Mais en Europe les accidents dus aux *Ctenus* tout en étant douloureux, n'ont pas la gravité de ceux observés dans les pays tropicaux. C'est un phénomène général sur lequel j'ai attiré antérieurement l'attention: par temps froid la réaction, normalement alcaline de ces venins, devient acide et leur activité baisse de mode parfois considérable.

Principales espèces dangereuses de l'Amérique du Sud

En première ligne viennent les grands *Ctenus (Phoneutria)* qui possèdent jusqu'à trois mgr. d'un venin très actif, neurotrope, provoquant de vives douleurs irradiantes avec rachialgie, des crampes, des contractions toniques pouvant aller jusqu'à l'opisthotonus et aux convulsions, des spasmes de la musculature lisse, des troubles circulatoires, tachycardie, arythmie, élévation initiale suivie de chûte tardive de la pression artérielle. La mort peut survenir en quelques heures, sinon, les symptômes s'atténuent lentement. Chez les petits animaux on observe du broncho-spasme, de l'oedème et des hémorragies pulmonaires.

Toutes les grandes espèces de *Ctenus* peuvent produire des accicents graves; les plus souvent responsables sont *C.ferus* et *C.nigriventer* sur le littoral brésilien dans les bananeries; *C.rufibarbis* dans le Sud du Brésil, au Paraguay et au Chaco. A l'époque de la reproduction, il n'est pas rare que ces araignées pénètrent dans les habitations et se cachent dans les vêtements, sous de vieux sacs, etc. causant des accidents fréquents. D'autres espèces sont responsables d'accidents en Colombie. Les Indiens du Matto Grosso connaissent parfaitement les *Ctenus* et les redoutent autant que les serpents. Ces araignées sont souvent transportées aux Etats Unis et en Europe avec le régime des bananes. Les grandes formes voisines: *Cupiennus* et *Enoploctenus* ne sont d'ordinaire pas dangereuses.

Latrodectus mactans. Cette espèce possède une vaste distribution géographique le long du littoral Pacifique, depuis la Californie jusqu'au Chili; elle existe également en Argentine, au Venézuela et dans les Antilles. La gravité des accidents varie selon les régions. De nombreux cas de mort ont été signalés en Californie: 31 sur 615 accidents par BOGEN (1936). En Amérique du Sud les cas de mort sont exceptionnels, mais les accidents sont toujours graves. En Argentine une statistique de SAMPAIO (1942) cite un cas de mort chez un enfant sur 260 observations; il ajoute cependant deux autres cas mortels communiqués par des Compagnies d'Assurance. Des cas de mort sont observés de temps à autre au Chili et dans les vallées tempérées de la Bolivie (Sucre, Cochabamba); ils sont l'exception au Pérou et aucun ne semble avoir été observé au Venézuela. Ce venin provoque une vive douleur irradiante avec rachialgie, des crampes cloniques pouvant simuler un abdomen aigu

(Gajardo), grande excitation psychomotrice et souvent état confusionnel. La réaction locale est généralement nulle dans le Sud du Continent et en Californie; en Bolivie et au Vénézuela existe un petit oedème suivi parfois d'une faible escarrhe. Dans les cas graves apparaissent des accidents rénaux tardifs avec hématurie et oligurie pouvant aller jusqu'à l'anurie; la mort est toujours due à cette néphrite aigüe.

Les Lycoses. Les grandes espèces de *Lycoses* très nombreuses en Amérique du Sud, surtout dans les régions tempérées, sont souvent la cause d'accidents plus ou moins graves. Les symptômes, très uniformes, sont purement locaux. C'est une nécrose dermique, sèche, parfois très étendue, succédant à une première période de congestion et d'oedème souvent considérable, avec phlyctènes, pouvant provoquer de vastes ulcérations. La douleur est modérée; il existe rarement une petite réaction fébrile. Les accidents évoluent lentement, aboutissant en une dizaine de jours à l'élimination d'une grande escharre. La cicatrisation est très lente. *L.raptoria* occasionne de nombreux accidents dans le Sud et au Centre du Brésil.

Loxosceles laeta est responsable au Chili de petits accidents nécrosants, locaux, connus sous le nom de „mancha gangrenosa", accompagnés de légères réactions fébriles et de douleurs locales plus ou moins fortes. Dans les cas graves apparaissent tardivement les symptômes d'hépatite et de néphrite pouvant entraîner la mort. URETA & ESPINOZA (1944) ont réuni une bibliographie de 96 accidents dus à ces espèces.

Segestria ruficeps. Des accidents mixtes avec grandes nécroses locales et graves manifestations hépatiques et rénales pouvant entraîner la mort ont été attribués à cette espèce au Chili et en Argentine. Ces faits n'ont pas été confirmés expérimentalement.

Mastophora gastheracanthoides. Plusieurs accidents, dont un mortel, ont été vus par ESCOMEL dans le Sud du Pérou (Quebrada de Majes) où cette espèce est appelée: „La podadora", la mutilante. On observe surtout une réaction locale intense accompagnée encore de symptômes hépatiques et rénaux. Nous ne retiendrons pas un cas de mort, foudroyant cité au Chili par URETA et qui, d'après cet auteur même, ne doit pas être attribué directement au venin.

Araneidae. Diverses espèces d'Araneidae, en particulier *A.audaux,* ont été accusées de produire des petites ulcérations locales sans grande importance.

Heteropoda venatoria. La morsure de cette grande espèce, ubiquiste dans les régions tropicales, peut être suivie d'une réaction locale assez forte avec phénomènes éruptifs quelquefois généralisés, lymphagite et parfois une petite réaction hépatique, ainsi que j'ai pu l'observer chez deux patients au Brésil et en Argentine. Un de ces cas a été attribué à une réaction anaphylactique.

Autres espèces. D'autres espèces ont été incriminées sans que leur rôle dans l'éthiologie des accidents ait pu être bien établi. Ce sont, en outre de *Segestria* déjà citée, *Filistata hibernalis, Polybetes pythagoricus* et diverses espèces de *Sparassidae.*

J'ai reçu de Bolivia la photographie, malheureusement peu nette, d'une espèce de cette dernière famille qui causerait à Cochabamba des troubles lo-

caux et généraux assez graves. Par contre il ne semble pas que diverses espèces de *Salticidae*, tel que *Dendryphantes noxiosus* et de *Thomisidae*, parfois accusées, puissent causer de véritables accidents.

Mygalomorphes. Aucune espèce de *Ctenizidae* n'a été incriminée jusqu'ici. La morsure des *Actinopus* n'est pas plus douloureuse que celle d'une guêpe. Parmi les *Dipluridae*, quelques unes possèdent un venin actif pour les vertébrés, surtout pour les lézards et les oiseaux; celui de *Trechona venosa*, est un des plus remarquables, comparable à ce point de vue à celui du serpent à sonnettes; mais le genre de vie de ces araignées ne leur permet guère de contacts avec l'homme; aucun cas de morsure n'est connu.

Les *Theraphosidae*, malgré leur grande taille qui les fait redouter dans toutes les régions tempérées, ne sont généralement pas dangereuses. Toutes les *Avicularia* étudiées se sont montrées inoffensives pour les mammifères et les oiseaux, ainsi que les *Gramostolinae*, dont plusieurs montrent, au contraire, une forte exaltation du venin pour les reptiles et les batraciens.

Le groupe des *Theraphosinae* fait exception et la plupart des grandes espèces de *Phormictopus*, de *Pamphoboeteus*, *Aconthoscurria* et *Xenesthis* peuvent causer des accidents graves, parfois mortels, chez l'homme. Les petites espèces d'*Aconthoscurria* et la plupart des *Lasiodora*, malgré leur grande taille sont peu dangereuses.

Les accidents sont de type mixte avec association de lésions gangréneuses locales et de symptômes hépatiques et néphritiques. Quelques cas de mort ont été signalés.

Traitement spécifique

A l'Institut de Butantan j'ai préparé avec Vital BRAZIL les premiers sérums thérapeutiques contre les principaux venins des espèces dangereuses du Brésil. J'ai pu obtenir ainsi trois types de sérum:

1. Anti-cténus, contre le venin neurotrope des grands *Ctenus* américains.
2. Anti-lycose, contre le venin nécrosant des *Lycoses*.
3. Un polyvalent contre le venin des *Lycoses* et des *Ctenus*.

Ces sérums sont toujours préparés par l'Institut de Butantan et ont été utilisés dans de très nombreux cas, plusieurs centaines, avec d'excellents résultats.

En Argentine P.PIROSKY et C.FRANCESCHI ont obtenu en 1941, en suivant une technique analogue, un sérum anti-latrodectus. D'autres sérums contre le venin de cette même espèce ont été préparés au cours de ces dernières années aux Etats Unis.

Il serait utile de préparer un serum polyvalent à base de venins de type mixte qui permettraient de combattre les accidents occasionnés par les *Theraphosidae* dont le venin est à la fois nécrosant et toxique.

Conclusions

Cette brève analyse des principales araignées sud-américaines dangereuses pour l'homme montre que si leur nombre n'est pas très élevé, beaucoup

d'entre elles sont largement répandues. Les accidents sont d'ailleurs bien plus fréquentes que les courtes statistiques publiées ne permettent de le supposer et toute enquête sérieuse auprès des médecins exerçant leur profession dans les campagnes et dans l'intérieur du Continent révèle de nombreux cas qui ne sont pas livrés à publicité. Il est fort probable que de nouvelles études augmenteraient la liste des espèces dangereuses et permettraient de mieux connaître les variations et les curieuses spécialisations de ces venins.

REVISION DER NEU BESCHRIEBENEN ARTEN DER GATTUNG ENOPLOCTENUS SIMON 1897*)

von

Wolfgang BÜCHERL
São Paulo, Brasilien.

Summary

Die 13 bisher bekannten Arten der südamerikanischen Spinnengattung *Enoploctenus* (Ctenidae, Acantheinae) wurden einer vergleichend morphologischen Untersuchung unterzogen. Als Vergleichsmaterial dieser ausgesprochenen Höhentiere dienten dabei die an die 100 grenzenden Individuen der Spinnensammlung des Institutes Butantan, von denen einige wenige Exemplare schon vor Jahren von den Prof. J.VELLARD und C.MELLO-LEITÃO bestimmt worden waren. Als typisches Biotop kommt für diese Gattung eigentlich nur die Gebirgsformation mit seinen Ausläufern und Nebentälern in Frage, die unter dem Namen „Serra do Mar" an der Atlantikkuste Südbrasiliens bekannt ist.

Eingangs wurden die bisher üblichen arttrennenden Merkmale auf ihre Gültigkeit untersucht und dabei einwandfrei festgestellt, dass die meisten von ihnen, von E.Strand, C.Mello-Leitão und E.Simon als von artentscheidender Wichtigkeit angesehen, wohl generisch brauchbar sind aber kaum spezifisch.

Es wurde auch verschiedene Male im Text auf die Arbeiten E.STRANDS hingewiesen und gezeigt, wie er an Hand von nur ganz wenigen, oft eines einzigen Individuums, dazu noch im Adolescenzstadium, die ihm im Berliner Museum vorlagen, 6 neue Arten beschrieben hatte, die alle mehr oder weniger als *synonym* anzusehen sind.

Anschliessend ein Verzeichnis der von uns als gültigen und synonym anangesehenen Arten:

Gültige Arten	*Synonyme Arten*
1. *Enoploctenus cyclothorax* (Bertkau) 1880	
	a) *E.germaini* Simon, 1896
	b) *E.janeiroensis* Strand, 1910
	c) *E.geralensis* Strand, 1910
	d) *E.zonatulus* Strand, 1910
	e) *E.wolfi* Strand, 1915
2. *Enoploctenus pedatissimus* Strand, 1910	

*) Originalabhandlung in Mem.Inst.Butantan, S.Paulo, 1951.

3. *Enoploctenus maculipes* Strand, 1910

a) *E. fallax*	Mello-Leitão,		1922
b) *E. strandi*	"	"	1936
c) *E. rondoni*	"	"	1922

4. *Enoploctenus morbidus* Mello-Leitão, 1939.

BRUTFÜRSORGE UND BRUTPFLEGE BEI EINIGEN BRASILIANISCHEN SPINNEN *)

von

Wolfgang BÜCHERL

São Paulo, Brasilien.

Summary

Die *Brutfürsorge* und *Pflege* der häufigsten südbrasilianischen Vogelspinnen (*Grammostola, Pamphobeteus, Acanthoscurria, Eupalaestrus* und *Lasiodora*) wurde in kurzen Zügen und auf das Wesentlichste beschränkt dargestellt.

Die Beobachtungen erstrecken sich auf 8 Jahre, während welcher hunderte von Spinnen in besonderen, auf gutes biologisches Millieu eingerichteten, Käfigen untersucht werden konnten.

Ausser den Vogelspinnen wurden auch *Phoneutria fera* (Ctenidae) und *Lycosa erythrognatha* (Lycosidae), die zu den giftigsten Spinnen Südamerikas mit gehören, studiert.

Bei all diesen Spinnen wurden die, unter den Namen „Brutfürsorge" fallenden Kopula, Gattenmord, Oothekbau, Eiablage, Aufsuchen eines guten Platzes, etc. näher beleuchtet und dargelegt, dass gegebene Abweichungen von der Norm ihre eigenen biologischen Hintergründe haben.

Während man bei den Vogelspinnen immer nur *eine* Eiablage nach je einer Jahrekopulation vorfindet, zeigen die *Phoneutria* und *Lycosa*-weibchen 3–4 hintereinander folgende Eiablagen nach einer einzigen Kopulation. Interessant ist auch, dass, während die Vogelspinnen-weibchen nach der einmal vollzogenen Kopulation und des Gattenmordes oder dessen Flucht kein anderes Männchen mehr an sich heranlassen, die *Phoneutria*- und besonders die *Lycosa*-Weibchen oft mehrmals hintereinander und zwar von verschiedenen Männchen, gegattet werden können.

Die Vogelspinnenweibchen verlieren auch während der Kopula keinen Augenblick ihre Aggressivität. Die *Phoneutria*- und *Lycosa*-weibchen jedoch verhalten sich dabei ganz passiv, wie „ohnmächtig" und werden von den Männchen zur Erleichterung der Samenübertragung bald links bald rechts hochgehoben und zur Seite gedreht.

Die Vogelspinnenweibchen pflegen ihren oft erstaunlich grossen Eisack mit den Chelizeren festzuhalten, wobei sie ganz sesshaft werden, die Vorderbeine oder Palpen darunter geschoben und so 40 bis 50 Tage reglos verbleibend. Die *Lycosa*-Weibchen heften dagegen den runden Eisack an die Spinnwarzen und tragen ihn so, frei schwebend, mit sich herum. Sie gehen also nicht zur Sesshaftigkeit über; nehmen Nahrung auf, wenn auch nicht regelmässig.

*) Originalabhandlung in Mem.Inst.Butantan, S.Paulo, 1951.

Die *Phoneutria*-Weibchen heften ihren Eisack an einen Untergrund, etwas über dem Boden und verpflanzen diesen von da nur an einen anderen Ort, wenn die biologischen Bedingungen ungünstig werden. Das Weibchen verbleibt immer in nächster Nähe, ohne aber direkt den Eisack anzufassen. Es entfernt sich manchmal kurz, um Nahrung aufzunehmen, lässt aber praktisch den Eiball keinen Augenblick ausser Sicht.

Die Vogelspinnenweibchen verbleiben ganz nahrungslos und halten während der ganzen Zeit den Eiball zwischen Vorderbeinen und Chelizeren fest.

Die *Brutpflege* äussert sich bei all diesen Spinnen sehr mannigfaltig, in Belüftung, Besonnung, Luftfeuchtigkeitsregelung, Schutz vor Feinden, Darbietung des eigenen Körpers als Schutz für die ersten Tage nach dem Schlüpfen der Jungen.

All diese Handlungen sowohl der Brutfürsorge als auch deren Pflege interessieren bei diesen Spinnen um so mehr, als wir es bei ihnen um ausgemachte Raubtiere zu tun haben, die auch keine andere Spinne verschonen, sondern ihr entweder ausweichen oder sie angreifen, töten und auffressen. Sie zeigen gewöhnlich ausgesprochene kannibalistische Tendenzen.

Dennoch sind die Wechselbeziehungen zwischen Muttertier und Jungen keine „bewusste", sondern beruhen auf Reflexen und Instincten. Eiballersatz, vertauschte Jungen, ja sogar verschiedener Gattungen, werden angenommen und betreut. Die Jungen versammeln sich auf Holzklötzchen ebenso wie auf dem Rücken der Mutter; statt der leeren eigenen Oothek ziehen sie sich auch in Kartonhüllen zurück, um zu übernachten.

SPERMIOGENESE BEI GRAMMOSTOLA ACTAEON *)

von

Wolfgang BÜCHERL

São Paulo, Brasilien.

Summary

Ausser *Grammostola actaeon*, die den Hauptgegenstand dieser Untersuchung bildet, wurden die Verhältnisse der Spermiogenese noch bei folgenden südamerikanischen Vogelspinnen *G.mollicoma; G.pulchripes; Pamphobeteus sorocabae; P.roseus; P.tetracanthus; P.cesteri; Acanthoscurria atrox; A.sternalis; A.violacea; Lasiodora klugii; L.curtior* studiert.

Methodologisch wurde wie folgt vorgegangen:

a) Geschlechtsreife Männchen wurden frisch getötet und die morphologischen Verhältnisse der Reproduktionsorgane untersucht.

b) Bei anderen Exemplaren wurden die ganzen oder Teile der Abdomina in Bouin fixiert, in Parafin eingebettet, in 5 micra dicke Serienschnitte aufgeteilt, mit Hämatoxilin-Eosin und nach von Gieson gefärbt und in Kanadabalsam aufbewahrt.

c) Die einzelnen Teile, wie die Hoden, die vasa deferentia, die Sammelräume oder „Nebenhoden", die vesicula seminalis wurden ebenfalls in frischem Zustand herauspräpariert und wie bei b) zu Dauerpräparaten verarbeitet.

d) Schlieslich wurden aus lebendem Material sowohl der Hoden, der vasa deferentia, der vesicula seminalis und des Kopulationsbulbus Objektträgerausstriche angefertigt uhd lebend sowie in fixiertem und gefärbtem Zustand untersucht.

Die Resultate dieser, bisher in dieser Hinsicht, noch nicht untersuchten Vogelspinnen, waren folgende:

„Apical, besonders in jüngeren Hodenfollikeln, liegen in Haufen die *Urspermiogonien* zwischen somatischen Zellen. Bei der Aufteilung ersterer in *Tochterspermiogonien* nach gewöhnlichen mitotischen Äquationsteilungen wandern sie mehr basalwärts, wobei die somatischen Zellen mitwandern. Dabei streckt sich das Plasma der somatischen Zellen immer mehr in die Länge, peripher um die Geslechtszellen herum und bilden schliesslich eine, die Spermiogonien, umfassende äussere Hülle, die *Spermiocysten* oder Samenfächer, in denen sich nun die folgenden Samenreifungsprozesse abspielen. Die früheren somatischen Zellen liefern also sowohl die Cystenwände als auch die Nahrung (Nährzellen).

*) Originalabhandlung in Mem.Inst.Butantan, S.Paulo, 1951.

Beim Übergang der letzten Vermehrungsteilung der Spermiogonien zur ersten Reifungsteilung machen die Kerne alle bekannten Phasen des leptänen, pachytänen und diplotänen Stadiums durch. Diese erste Reifungsteilung ist eine Reduktionsteilung, wobei aus je einer Spermiocyte I. Ordnung je 2 Spermiocyten II. Ordnung hervorgehen, die nunmehr einen haploiden Chromosomensatz aufweisen. Man kann in mikroskopischen Bild die Verringerung der Chromosomen wohl erkennen, aber ihre Zahl ist dennoch zu hoch, um sie genau festlegen zu können.

Die 2. Reifeteilung, wobei aus je 1 Praespermide je 2 Spermiden hervorgehen, ist wiederum eine Äquationsteilung. Die *Spermiden* zeigen einen kleinen, halbmondförmigen, an der Peripherie gelagerten Kern, dessen eines Ende immer mehr sich der Äquatorzone nähert und sich so allmählich verdünnt und verlängert, um so schliesslich allmählich zu dem langen, walzenförmigen Kopfstück des Spermiums heranzuwachsen. An der Basis dieses Kopfes sieht man deutlich einen nach hinten gebogenen Seitenfortsatz, den wir als „Mittelstück'' deuten möchten. Die Schwanzgeissel ist kaum halb so lang wie das Kopfstück.

Am Anfang der Geissel kann man eine ondulierende Membran unterscheiden. Selbst die voll ausgereiften Spermien besitzen keine grosse Eigenbewegung. Ihre Fortbewegung ist nur sehr langsam, mit häufiger Spiraldrehung.

BIOLOGIE ET ETUDES FAUNISTIQUES DES ACARIENS

par
Jean COOREMAN
Uccle-Bruxelles, Belgique

Lors du VII^{o} Congrès International d'Entomologie à Berlin, en 1938, notre regretté collègue, le Prof. Ivar TRÄGÅRDH, mettait en évidence la confusion qui régnait dans la systématique des Acariens en général, des Mesostigmata en particulier. Sans vouloir reprendre les causes d'une situation dont tous les Acarologues ont nettement conscience et dont souffrent plus particulièrement les systématiciens, qu'il me soit permis de rappeler les directives que proposait I. TRÄGÅRDH pour remédier à la carence actuelle et faire progresser l'étude des Acariens, dont dépendent de si nombreux et de si importants problèmes. Remédier à l'état chaotique de la littérature systématique – suivant ses propres paroles – par l'établissement de monographies de genres et de familles et, d'autre part, entreprendre des recherches aussi complètes que possible de leur biologie, de leur écologie et de leur anatomie.

Je voudrais aujourd'hui souligner une fois de plus l'importance de l'étude biologique des Acariens – non en tant que discipline propre, ce dont personne ne doute – mais en fonction des recherches systématiques elles-mêmes, et surtout dans le cadre de la faunistique ou de l'étude de leur répartition géographique.

Par biologie j'entends ici l'étude aussi complète que possible du cycle de développement de l'espèce, c'est-à-dire la connaissance morphologique de tous ses stades, la durée moyenne de ce cycle, la détermination de son biotope normal, et dans une certaine mesure au moins, les facteurs principaux qui influencent ce développement.

On ne connaît pas une espèce si l'on n'en possède qu'un stade immature, pas plus qu'on ne peut conclure à sa présence dans un habitat si l'on s'en réfère à une capture isolée, peut-être accidentelle.

Les méthodes d'élevage ne peuvent donner de résultats que dans des cas particuliers; on se heurte ici à de nombreuses difficultés techniques et l'isolement en milieu artificiel constitue déjà, dans le cas des Acariens libres, un facteur contrariant. Néanmoins les élevages in vitro demeurent une méthode d'appoint susceptible de donner de remarquables résultats. Mais l'étude des Acariens dans la nature, au sein de leur milieu propre, soumis aux influences multiples et complexes de leur microclimat et aux interactions qui se manifestent dans leur biocoenose, est souvent la plus adéquate au but poursuivi.

Très nombreuses sont les espèces d'Acariens dont nous ne connaissons encore que le seul stade de vie latente de leur deutonymphe migratrice. Celui-ci, le plus souvent a été décrit d'après des spécimens capturés sur les agents dont ces Acariens se servent pour assurer leur dispersion par phorésie. C'est le cas notamment de nombreux Uropodes et, plus fréquemment encore, chez

les Acaridiae. Du point de vue systématique, c'est là une carence qui ne pourra être comblée que par des recherches sur le comportement de ces Acariens dans la nature. Qu'il me soit permis de rappeler ici le cas de *Vidia concellaria* Cooreman que j'ai eu l'occasion d'étudier en 1949. La deutonymphe de cet Acarien se fait véhiculer par des Hyménoptères Sphégides, *Cerceris arenaria* Linne, ou par leur parasite, *Hedichrum nobile* Scopoli. Le cycle de cet Acarien est annuel. Or son développement comporte des phases très inégales en rapport avec le développement de son hôte, auquel il est très strictement lié. La phase passive de deutonymphe hypopiale occupe environ 11 mois et demi de l'année, tandis que toute sa vie active – Nph. III, Adultes, Lv. et Nph. I – se déroule en l'espace de 15 jours. De plus, toute la vie de cette espèce est endogée, à l'exception des quelques jours, voire des quelques heures, où, au stade de DN. il se fait véhiculer par son hôte. Il est évident que dans un tel cas, la découverte des Adultes est pratiquement impossible, si l'on ne peut pas suivre le développement complet du cycle de l'espèce.

Lorsque, au cours de recherches faunistiques, on veut s'assurer de la présence ou de l'absence d'une espèce d'Acarien libre dans un pays, une région ou un milieu donnés, il ne suffit pas d'y pratiquer des récoltes, quelles que soigneuses qu'elles soient. En effet deux cas peuvent se présenter et fausser les résultats. Ou bien on ne connaît pas exactement le biotope particulier où s'accomplit le développement de l'espèce et les résultats des „coups de sonde" pratiqués sont livrés au hasard. Ou bien on connaît l'habitat normal de l'espèce, mais on ignore les fluctuations dans le temps de son cycle de développement, et le résultat des recherches dépendra encore du hasard, c'est-à-dire d'une coïncidence heureuse ou malheureuse entre le moment des récoltes et celui du cycle de l'espèce.

Le premier cas est celui d'un très grand nombre d'espèces dont on ne connaît, jusqu'à présent, que de rares captures, parfois même dont on ne possède que des spécimens uniques ou la seule description originale, et sans indications d'habitat assez précises pour orienter les recherches.

Or la présence de spécimens rares ou isolés, s'il n'est pas le fait de méthodes de récoltes inadéquates, est ordinairement un indice permettant de présumer que le biotope où ils se trouvaient, n'est pas leur milieu naturel; ils y sont à titre accidentel ou transitoire.

De multiples exemples pourraient illustrer ce fait.

Des recherches faunistiques, encore actuellement en cours, dans la région des Hautes Fagnes, en Belgique, m'ont permis de préciser quelques données sur la répartition et les biotopes des *Porohalacaridae* de cette région.

Je ne prendrai ici que le seul exemple de *Lobohalacarus weberi* Viets. Pour éliminer le facteur temps, je choisis un exemple où toutes les prises d'échantillons furent faites le même jour.

Soit les biotopes A, B, C, etc. qui peuvent être voisins de quelques mètres seulement et les biotopes A, A', B, B', etc. qui peuvent être fort éloignés l'un de l'autre, mais sont indentiques par les composantes biocoenotiques.

Rapportant les échantillons à un volume sensiblement égal, nous obtenons es chiffres suivants:

	Biotopes								
	A	A'	B	B'	C	D	E	F	F'
ombre d'exemplaires 9–III	77	84	0	0	144	0	364	266	322

De l'examen de ces récoltes, et malgré l'abondance de spécimens en certains points, on ne peut pas déduire que l'habitat de cette espèce correspond ux endroits où il était abondamment représenté. En effet, l'analyse de ces ifférents milieux au cours de plusieurs mois nous a montré que seul le biotope *E* ne subit pas de fluctuations sensibles et que les récoltes y sont contantes en des endroits très éloignés les uns des autres (E, E', E'', etc.); 'est le biotope normal de l'espèce. Au contraire les autres biotopes, y compris F et F', sont des endroits collecteurs où l'espèce a été amenée et peut e maintenir temporairement, ou disparaître brusquement.

	E	F	F''
Exemple, le 19–VI	448	0	70

La présence de l'espèce en *F* est aléatoire, tandis qu'en *E* elle est habituelle. On voit donc, au point de vue faunistique, que si l'on n'est pas averti, une prise d'échantillon en *F* donnera un résultat positif ou négatif suivant e cas.

Un autre exemple pourrait encore être cité, qui montre combien la connaisance suffisante des besoins d'une espèce peut orienter utilement la recherhe de son habitat. C'est le cas du Trombidiide *Johnstoniana errans* Johnton. Les individus adultes de cette espèce vivent ordinairement à l'état olitaire et très dispersé, aussi sa capture est-elle relativement rare et assez roblématique. Ayant étudié l'ensemble des récoltes faites en Belgique en 947, je concluais qu'un certain nombre de facteurs, exigés par le développement de l'espèce dont la larve est parasite des Tipulides, devaient caractériser son biotope. Ce fait fut pleinement confirmé lorsque, en juillet 1950, e capturais 45 specimens (44 ♀♀ et 1 N.) au même endroit, correspondant à es desiderata présumés. Il s'agissait d'une petite bande de terre très huide, de 0.50 x 1 m, située à proximité d'un ruisseau, dans un Molinietum des autes Fagnes de Belgique. C'était, en quelque sorte, un point de rassemlement „obligé" de cette espèce.

On sait le développement qu'ont prises les recherches écologiques au ours des dernières années et leur rôle dans l'étude de l'évolution des sols. est inutile de rappeler ici la place importante qu'occupent les Acariens armi les associations animales qui tiennent un rôle dans ce domaine. Ici

encore il me semble qu'on n'a pas suffisamment mis en lumière qu'une connaissance préalable de la biologie des espèces dominantes est des plus utiles pour se faire une idée adéquate de leur rôle. Une biocoenose est une population en état de perpétuel mouvement; elle se modifie constamment sous l'influence de facteurs extrêmement complexes. Mais il est très difficile, sinon impossible, de comparer des associations dans l'espace si l'on n'a pas une vue d'ensemble des fluctuations dans le temps de la population d'ùn même biotope.

Au cours de recherches inédites sur le comportement d'une association Acariens-Insectes, vivant dans un biotope à Hypnum molluscum Hedw, en Belgique, j'ai constaté que, dans les conditions de l'observation, une telle biocoenose suit un rythme tel que seule l'étude portant sur une année au moins peut en refléter l'aspect et que des modifications anormales du climat lui impriment des modifications prévisibles dans une certaine mesure. Pour cette étude, le biotope avait été choisi pour présenter un minimum de variables, de même qu'avait été écartée la possibilité de migration verticale; absence-présence étant de ce fait directement liées aux facteurs microclimatiques. Seule était inévitable l'intrusion accidentelle et temporaire d'espèces étrangères au milieu, facilement décelables d'ailleurs à l'analyse.

L'ensemble des relevés au cours de 19 mois portaient sur l'analyse de plus de 52.800 specimens et se répartissaient en 95 espèces. Cependant la population „régulière" du biotope ne comprenait pas plus de 25 espèces. Si l'on s'en tient ici aux seules *espèces dominantes*, on constate que l'aspect de la biocoenose varie au cours de l'année.

Exemple:

mai 1946	*février 1947*	*mai 1947*
Nanorchestes arboriger Berl. 43.6 %	*Oribatula tibialis* Nic. 27.5 %	*Nanorchestes arboriger* 32 %
Eupodes sp. 33.2 %	*Minunthozetes pseudofusiger* Schweiz. 11 %	*Notaspis punctata* 19.7 %
Oppia splendens C.L.Koch 9.5 %	*Notaspis punctata* Nic. 11 %	*Oribatula tibialis* 16.4 %
Quadrioppia quadricarinata Mich. 5.2 %	*Eupodes sp.* 6.8 %	*Quadrioppia quadricarinata* 12.3
		Oppia splendens 9.8 %

On voit aussi que la dominance de *Eupodes sp.* en mai 1946 est remplacée en mai 1947 par *Notaspis* et *Oribatula.*

Enfin certaines espèces s'avèrent remarquablement constantes dans ce milieu, tandis que d'autres sont transitoires, suivant un cycle ou non.

La composition d'une population d'un habitat apparemment très homogène est une notion essentiellement dynamique. C'est pourquoi les qualificatifs „rares" ou „communs" appliqués par les systématiciens aux espèces doivent être pris dans un sens tres relatif. Et quand il s'agit d'Acariens libres, pour autant que les méthodes de récolte soient adéquates et identiques entre elles, de tels termes n'expriment qu'une notion qui est fonction du biotope considéré et du moment de l'espèce.

Dans le biotope dont il était question ici, par exemple, *Conoppia microptera* Berl. était représenté comme suit:

mois	nombre d'exemplaires par unité d'échantillons
II	0
III	35
V	25
VI	2
VIII	0
X	10
XII	2

Une prise d'échantillon isolée, en II ou VIII, considérerait cette espèce dans ce biotope comme inexistante, en VI ou XII comme rare, en III ou V comme très commune.

Conclusions

Les quelques exemples mentionnés ici montrent qu'il serait souhaitable que se multiplient les recherches sur la biologie des Acariens, tout particulièrement au sujet des Acariens libres. Le systématicien lui-même ne pourra pas résoudre certains problèmes tels que la connaissance de tous les stades d'une espèce, et ses affinités avec d'autres espèces, et dans certains cas même, sa position systématique exacte, sans y recourir. L'étude de la répartition géographique des Acariens en particulier, ne peut progresser si on néglige de faire des recherches plus approfondies de leur écologie et de leur éthologie. On ne peut pas se faire une idée de la faune d'une région en se fondant sur des récoltes faites au hasard des lieux et du temps. Et, à cet égard, on peut dire que les faunes exotiques nous sont encore complètement inconnues.

Les récoltes faites par des non-spécialistes sont habituellement dépourvues de toute précision sur le biotope, et de ce fait, ne permettent aucune orientation pour des recherches futures. L'indication du biotope, plus encore

que celle de sa localisation exacte, est indispensable à cet égard. Etant donné l'extrème exigeance de nombreuses espèces pour un biotope restreint, des mentions telles que „Afrique" ou „Katanga", ou „environs de telle localité" ou encore „parmi les mousses, Amérique du Sud", etc. sont pratiquement sans valeur.

C'est d'ailleurs à cause de cette absence de précisions que tant d'espèces anciennes, dont le type a disparu, n'ont jamais pu être redécouvertes et que, faute de pouvoir retrouver des topotypes, le systématicien demeure dans l'ignorance de leur identité réelle.

A mesure que progresseront nos connaissances des Acariens, leur étude biologique sera nécessairement de plus en plus intimement liée à leur étude systématique et faunistique.

DISCUSSION

Mr. **Stammer**: Wie weit hängen die Schwankungen der faunistischen Zusammensetzung des gewählten Beispiels von der Eigenart des Biotops ab?

Mr. **Cooreman**: La cause des variations et de leur amplitude sont multiples et complexes (et l'un de ces facteurs est l'évolution biologique des espèces considérées, dans le milieu envisagé); ce problème ressort de l'étude biocoenotique. Mais je n'envisage ici que les résultats de ces variations, au point de vue des études faunistiques et de répartition des espèces. Toute variation qui se manifeste par de grands écarts dans un biotope donné ne peut se constater que par une étude de ce dernier, poursuivie pendant un temps minimum; en d'autres termes un relevé isolé ne permet pas de conclusions quant à la composition réelle de la population de ce milieu.

Mr. **Van Eyndhoven**: Il me semble très important de choisir des biotopes de construction très, très simple, au moins au commencement, pour faciliter la comparaison.

Mr. **Cooreman**: Oui, c'est pour éliminer un certain nombre de variables que fut choisi ce biotope à Hypnum molluscum sur substrat rocheux.

Mr. **Haarløv**: Which size and number of samples can be recommended?

Mr. **Cooreman**: Pour l'exemple donné du biotope à Hypnum molluscum c'est env. 1 litr. pour une surface de 400 cm^2. On a fait des récoltes mensuelles ou bimestrielles pendant 19 mois.

Mr. **Haarløv**: What is the variation in number of the species on the habitat ?

Mr. **Cooreman**: Cette variation était très faible dans ce biotope, ne portant que sur des espèces transitoires.

QUELQUES MOTS SUR LA LITTERATURE ACAROLOGIQUE

par
G.L. VAN EYNDHOVEN
Haarlem, Pays Bas

Ayant l'avantage de voir le IXe Congrès International d'Entomologie chez nous aux Pays Bas, je profite de l'occasion pour vous montrer quelques livres, pour la plupart de la bibliothèque du feu Dr A.C.OUDEMANS, lesquels sont rares, ou du moins sont généralement difficilement accessibles aux acarologues. J'en ai apporté plusieurs volumes que je ferai circuler.

D'abord l'oeuvre de Pierre LYONET: Anatomie de différentes espèces d'insectes. On y trouve aussi quelques acariens. LYONET était célèbre, e.a. par ses observations et ses dessins très exacts. Le livre en question a été publié après son mort (1789) par W.DE HAAN en 1832.

Puis il y a le livre fondamental de Jean Fréderic HERMANN (mort 1794) publié par Fréderic Louis HAMMER en 1804. Malgré un grand nombre de publications dans lesquelles on trouve des descriptions d'acariens, aucun auteur n'avait écrit jusqu'ici un livre spécial sur ces petits animaux, ni donné de si belles planches. HERMANN commence par des observations générales concernant l'étude des acariens. Ses idées de systématique ne peuvent pas être maintenues, mais ses descriptions et ses figures sont minutieuses, spécialement en tenant compte des difficultés d'observation dans ces temps-là.

Quelques dizaines d'années plus tard nous trouvons le grand oeuvre de C.L.KOCH de Regensburg, publié entre 1839 et 1843 et contenant des centaines de figures avec leurs descriptions, les dernières très petites, hélas, et difficiles a déterminer, mais dessinées très minutieusement. Toutes les figures sont en couleurs. L'oeuvre est très, très rare.

Les livres susdits, ainsi qu'un grand nombre d'autres publications, tous datés entre 850 av. Chr. et 1850, avec toute leur confusion et souvent beaucoup de rareté, ont donné lieu au Dr A.C.OUDEMANS à réunir tous ces détails dans un oeuvre magistral „Kritisch Historisch Overzicht der Acarologie". On y trouve tous les acariens décrits pendant ces années, avec leurs diagnoses, copies des figures, etc. et OUDEMANS y a ajouté des notes critiques. Cet oeuvre nous permet d'avoir à la maison toute la littérature publiée avant 1850 et je crois que seulement une autorité comme OUDEMANS, avec son sens historique et avec sa connaissance phénomenale des acariens et de leur littérature, était capable d'entreprendre ce travail avec du succès. Je ne veux pas dire que toutes ses conclusions et déterminations soient correctes; ceci est impossible dans une confusion si grande. Mais cet oeuvre donne pour la première fois la possibilité d'arriver à une interprétation uniforme concernant les espèces des anciens auteurs.

Je vous montre quelques volumes de cet oeuvre qui a été publié en 3 parties: I: 850 av.Chr. – 1758; II: 1759 – 1804; III (vols. A–G): 1805 – 1850.

OUDEMANS avait l'intention de publier encore une 4e partie, qui s'occuperait de la période 1851 – 1880. Quand il mourut en 1943, il avait traité les 10 premières années en manuscrit, mais ce manuscrit ne pouvait pas être complet comme la guerre l'empêchait de consulter les livres dans les bibliothèques étrangères.

Environ 1880 il y a plusieurs savants qui commencent à étudier spécialement les acariens. Je voudrais mentionner ici seulement Antonio BERLESE et Giovanni & Riccardo CANESTRINI.

La productivité énorme de BERLESE est bien connue et l'on se demande comment il a été possible d'effectuer une telle quantité immense de travail. BERLESE était un excellent dessinateur et spécialement pendant les premiers décennia, il a dessiné souvent directement sur la pierre de lithographie ce qu'il vit dans le microscope. Inutile de dire qu'il y avait des inexactitudes et même des erreurs et spécialement les publications de cette première époque doivent être étudiées bien critiquement. Plus tard, aussi par l'influence de OUDEMANS, l'oeuvre de BERLESE est devenue plus exacte.

L'influence de BERLESE sur l'acarologie a été très, très grande; il faisait autorité qu'aucun savant en ce groupe, dans mon opinion, n'ait gagnée.

Je dois me borner à vous montrer quelques planches de son oeuvre célèbre: „Acari, Myriopoda et Scorpiones hucusque in Italia reperta" (1882 – 1898), laquelle contient des centaines de figures en couleurs avec des descriptions.

A côté de BERLESE nous voyons G. et R. CANESTRINI, dont spécialement Giovanni a beaucoup publié et je vous montre un volume du „Prospetto dell' Acarofauna Italiana" (1885 – 1899) qui a paru en 8 volumes.

Une oeuvre récente et bien importante est „Acarina" de Hermann Graf VITZTHUM, faisant partie de Bronns Klassen und Ordnungen des Tierreichs (1940 – 1943). Ce livre nous donne une synthèse de l'acarologie dans toutes ses diversités et son contenu universel fait que véritablement aucun acarologue ne peut s'en dispenser.

Pour terminer je voudrais vous montrer une photocopie des figures publiées en 1812 quand l'étudiant français J.C.GALÈS écrit son „Essai sur le diagnostic de gale...". GALÈS a réussi à mettre des exemplaires de *Tyroglyphus farinae* (L. 1758), qu'il avait sous les ongles, sous le microscope, en suggérant que c'était la vraie „mite de la gale". Tous les savants l'ont cru et ce n'était qu'en 1835 que Simon François RENUCCI dans son „Thèse sur la découverte de l'Insecte qui produit la contagion de la Gale, du Preurigo et du Phlyzacia" démontrait la vraie nature de l'*Acarus siro* (L. 1758), l'acarien de la gale.

La thèse de RENUCCI semble être extrêmement rare. Le Muséum National d'Histoire Naturelle à Paris en possède un exemplaire, tandis que moi-même j'en possède un deuxième. Ce sont les seuls 2 exemplaires que nous avons pu découvrir jusqu'ici.

SOME REMARKS ABOUT THE SPECIES OF MYOCOPTES (ACAR.

by
G.L. VAN EYNDHOVEN
Haarlem, Netherlands

Summary

The Latin diagnosis of *Myocoptes romboutsi* v. Eyndh. 22. V. 1946 ha
been given in the Entom. Berichten, **12** (267/8): 30–31. So far the drawing
of the new species have not been published.

These drawings are shown here, and various species of the genus *Myo-
coptes* are discussed. The publication of these details will be made elsewhe-
re.

ALPHABETICAL INDEX OF AUTHORS AND PAPERS

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